FACTORS INFLUENCING BICYCLE ROUTE SELECTION

by

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Chapter 1

INTRODUCTION

Bicycles are potentially a viable answer to commuter demands for transit modes that can provide personal transportation while alleviating the congestion, pollution, noise, and expense of automobile transit. Bicycles need to be more effectively incorporated into the transportation network because they are energy efficient, inexpensive to operate and maintain, occupy a minimum of space in the urban environment, provide versatility that few modes achieve, are time competitive with the existing modes, and a bonus to one's health and welfare. Although bicycles are becoming increasingly popular, these qualities and others presently are not being realized as many people are deterred from bicycling because cyclists are forced to compete with motor vehicles for a piece of the road. Bicycle technology, current use, and public opinion survey results indicate that the bicycle is a viable form of adult transportation for short urban shopping, work, and recreation trips, but that there is a need for facilities that support bicycle travel.

This thesis concentrates not on the design of bicycle paths but rather the route selection behavior of the cyclist. It identifies the factors that influence the selection of a route by a bicyclist and the variability of those factors with respect to different trip purposes, user types, and socio-economic status. Hopefully the findings of this thesis will promote the design of bikeways that account for the cyclist's perception of route priorities beyond engineering considerations.

Popularity of Bicycles

In recent years the bicycle has become a more popular alternative mode of travel for multi-purpose, short distance, intra-urban trips in the United

States. This popularity can be measured both in terms of the number of bicycles in use and the number of people who use bicycles.

The number of bicycles in use increased from 32.9 to 53.1 million during the period between 1965 to 1971, a 61 percent increase.[1] From 1960 to 1970, the number of people who used bicycles increased from 35.2 to 75.3 million and the use of bicycles is expected to continue to escalate in the future.[2]

Bicycle Users And The Advantages Of Bicycling

Most bicycle users can be placed in one of the following categories: (1) the transportation-deprived who cannot afford other means of transportation and whose only alternatives are walking and bicycling; (2) recreational or casual users who ride for their own personal enjoyment during periods of free time and relaxation; (3) bicycle buffs who are a small but vocal group of hardcore cyclists who use the bicycle for any trip purpose; and (4) utility users who use the bicycle as a regular mode of travel for commuting and errands.[3]

Bicyclists generally make trips for six purposes. These include; (1) school trips; (2) shopping trips; (3) personal business trips (socializing); (4) recreational trips; (5) health trips (exercise); and (6) work trips.[4]

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[1] Nina Dougherty and William Lawrence, Bicycle Transportation, U.S. Environmental Protection Agency, Office of Planning and Evaluation, (Washington, D.C.: Government Printing Office, 1974), p. 10.

[2] James J. Hayes, "Bicycles In The Modal Mix - The Scope Of The Problem" (Paper Presented at the Seminar on Bicycle/Pedestrian Planning and Desigr, Walt Disney World, Florida, December 1974).

[3] Dougherty and Lawrence, op. cit., p. 67.

[4] Carl E. Ohrn, "Estimating Potential Bicycle Use and Public Investment" (Paper Presented at the 43rd Annual Meeting of the Institute of Traffic Engineers, Los Angeles, April 1972).

The intensity of bicycle use relative to other modes is affected by several factors: trip purpose, trip length, climate, age, bicycle ownership, cost, occupation, and socio-economic status.[5]

What does the bicycle offer that attracts increased adult interest as a mode of urban travel? Some of the more important advantages of the bicycle over the automobile include the following:

(1) The bicycle is inexpensive to operate and maintain. It requires low capital outlay, low maintenance and depreciation costs, and low operational costs. The cost of a new automobile is rarely below $2750, while a new bicycle can be obtained for as little as $50. The most popular bicycle today is a lightweight, multi-speed model which costs from $75 to over $400, with the more common models (ten speeds) averaging around $150. Bicycle repairs and maintenance average from .2 to 2 cents a mile, while the automobile averages around 15 cents per mile to operate.[6] Mass transit costs fluctuate upward from a 25 cent fare, but the true costs of the operation and maintanance of the system are covered by heavy government subsidations. The cost for the construction of bikeway facilities is much lower than that for highway construction in urban areas. Bikeways separated from the existing transportation

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[5] Carl E. Ohrn, "Estimating Potential Bicycle Use and Public Investment" (Paper Presented at the 43rd Annual Meeting of the Institute of Traffic Engineers, Los Angeles, April 1972); D. T. Smith, Safety & Locational Criteria For Bicycle Facilities USER Manual Volume 1: Bicycle Facility Location Criteria, U.S. Department of Transportation, Federal Highway Administration No. FHWA-RD-75-113 (Washington, D.C.: U.S. Government Printing Office, 1976), pp. 58-65; D. T. Smith, Safety And Locational Criteria For Bicycle Facilities Final Report, U.S. Department of Transportation, Federal Highway Administration Report No. FWHA-RD-75-112 (Washington, D.C.: U.S. Government Printing Office, 1975), pp. 216-224; Seattle Engineering Department, "Bikeway System Planning And Design Manual" (Seattle, Washington: Seattle Engineering Department, 1975), pp. 36-40. (Mimeographed.)

[6] Dougherty and Lawrence, op. cit., p. 14, (Note: The Studies listed in Footnote 5 also have detailed discussions of the cost benefits of the bicycle).

network average $20,000 a mile to build compared to $1 million a mile for highways.[7]

(2) Bicycling is a bonus to one's health and welfare. According to Dougherty and Lawrence, cycling ranks behind running and swimming as the best means of exercise.[8] For many it is a pleasant way to acquire and maintain physical fitness, control body weight, enhance the cardiovascular status, develop a slower heart rate, lower blood pressure, and increase strength and endurance.[9] The bicycle also offers great recreational opportunities and allows one to escape from the growing sense of social confinement of the city.

(3) The bicycle requires a minimum of natural resources for production, operation, and maintenance. The increased use and acceptance of bicycles, along with a transition from automobile travel to a mixed mode form of transportation such as the bicycle-bus contingency, would decrease the depletion rate of some nonrenewable resources such as fossil fuels. If bikeways were used as the basic facility for bicycle transportation, less land would be used than if highways were constructed. Bikeways require a path 8 feet in width plus a minimum of righ-of-way as compared to a path 50 feet in width plus over 120 feet for the right-of-way required for two lane highways.[10]

(4) The problem of air and noise pollution can be reduced with the increased usage of the bicycle. One of the major sources of noise and air pollution in cities today is the automobile. Bicycles operate in almost complete silence.

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[7] Ibid.

[8] Ibid., (See also H. K. Hellerstein, "Health Aspects of Bicycling") (Bicycles, U.S.A. Conference, Cambridge, Massachusetts, May 1973), p. 1.

[9] Balshone and others, Bicycle Transit: Its Planning and Design, (New York: Praeger Publishers, 1975), p. 81; Joseph De Chiara and Les Koppelman, Urban Design and Criteria, 2nd ed. (New York: Van Nostrand Reinhold Company, 1975), pp. 256-260.

[10] Dougherty and Lawrence, op. cit., p. 13.

Not only is there less noise pollution, but bicyclists can maintain an auditory correspondence with their surrounding environment.

(5) The bicycle occupies a minimum of space for parking and moving. Studies have estimated that 14 to 20 bicycles could occupy the space necessary to park an automobile.[11] So bicycles obviously contribute less congestion in urban areas than do automobiles.

(6) The bicycle provides versatility that can be obtained from very few other vehicles. It provides door-to-door service that an automobile cannot provide because of parking restrictions. The bicyclist can also travel in areas where larger vehicles are excluded.

(7) The bicycle is time competitive with the automobile and mass transportation for trips of less than four miles within most urban areas. The average speed of both the car and the bicycle is 13 miles per hour in urban traffic.[12] More than 43 percent of all urban work trips made by the automobile in the United States are four miles or less in length. The driver is the sole occupant of the vehicle in 9 out of 10 of those trips and one study stated that bicycles realistically could handle over 40 percent of those work trips if the proper bicycling conditions exist.[13]

(8) The bicycle is one of the most energy efficient transportation vehicles for short distances. A bicyclist moving at 12 miles per hour uses only 97 BTUs per passenger mile, whereas a pedestrian uses 500 BTUs per passenger mile walking at 2.5 miles per hour. The bicyclist traveling at 12 miles per hour is reaching the equivalent of 1,000 passenger miles per gallon of

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[11] Nina Dougherty, "The Bicycle vs. The Energy Crisis," Bicycling!. January 1974, p. 39.

[12] Simon Breines and William Dean, The Pedestrian Revolution: Streets Without Cars, (New York: Vintage Books, 1974), pp. 81-82.

[13] Dougherty, op. cit., (Also Dougherty and Lawrence, op. cit.)

petroleum fuel. More energy is consumed by the automobile for short trips than for longer trips because the automobile is less efficient in the urban environment due to constant acceleration and deceleration, cold engines, and idling in traffic. Bicycling and walking are ten to forty times as energy efficient as motorized transport. If the bicycle were used for all urban trips of four miles or less there would be about six percent savings in total energy consumption and twenty-five percent savings in energy consumed by transportation for all work trips. This would be a savings of 10.5 billion gallons of petroleum per year.[14] Many bicycle advocates could possibly add to this list, however this list is sufficient to point out the utility of the bicycle as a viable means of transportation in terms of efficiency, cost, and space.

Problems With Bicycling

Bicycling is not without difficulties. Many people are deterred from cycling because most of the present roads do not have special lanes for bicyclists and they are forced to compete with motor vehicles for a piece of the road. The bicyclist is in a dangerous environment and the number of accidents, injuries, and deaths associated with bicycling has increased dramatically the past few years.[15]

Bicycle accidents can be classified as two basic types: collisions and falls. Falls are more frequent, but collisions account for the majority of fatalities and major injuries. The number of injuries could be reduced if decision-makers established protected lanes and paths for bicycles away from traffic, eliminated obstructions from the roads, designed a safe bicycle, improved the design of intersections, established educational programs about

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[14] Dougherty and Lawrence, op. cit., pp. 15-16. (Others cited in text footnote.)

[15] Ibid.

safe bicycle riding, and enforced uniform traffic laws.

Bicycle security is another difficult problem that a bicyclist faces. Over a half million bicycles are stolen annually. New bike storage and lock systems are needed in addition to more active programs in theft prevention.

The bicyclist who rides on the same facility as motorized vehicles is exposed not only to collision dangers, but also to a variety of air pollutants. The cyclist is exposed to emissions and particulates put out by the internal combustion engine and to other particulate matter from the road surface. Bikeways located away from the automobile congested areas would help to reduce this hazard.

The bicyclist also faces the problems of inclement weather conditions, inability to carry additional packages and time costs. In summary, bike route planners need to design bicycle facilities and trails such that safety and economic efficiency will be reinforced and not merely assume that the construction of a bicycle route will call forth in its own demand. The bike route must satisfy the desires of the bicyclists in order for the demands to be satisfied for the bike facility. Bicycling needs to be made more convenient in order for it to increase its status as a mode of urban transportation.

Accommodating the Bicycle

Although the demand for bicycling has increased, widespread acceptance of the bicycle as a major, inexpensive, clean, and healthy mode of urban transportation will occur only if safe, convenient bikeways exist, What has been done to integrate the bicycle into the transportation network? The government at all levels, with help from traffic planners and bicycle organizations, has responded by the funding, planning, and construction of bikeways. Bikeways are defined as all the facilities that are designed to provide for bicycle travel. A bikeway system must provide continuity and should offer safe and community-wide accessibility equal to that offered the automobile.

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Bikeway systems have generally been placed on/or alongside existing arterial and collector streets. Only a few systems have been placed completely separate from the existing transportation network. In some cases the cost of completely separated bikeways prohibits the construction of such a facility, leaving no alternative but to place the bicyclist on the streets with the other modes. So the bicyclist rides in a dangerous environment with a constant fear of the automobile.

The physical nature (engineering) of bikeways has been studied in detail, but most of the bikeway studies have avoided studying the bicyclist in detail. The bicyclist is often looked at in terms of age, potential users, types of trips, accidents, accessibility, occupation, and other user characteristics, or simply as a statistical entity. It is not just a question of will the bikeway fit the design criteria. The planner should think more in terms of fitting the bikeway to the desires of the bicyclist to satisfy their perception of what is safe and efficient. In order for safe, effective, and widely accepted bikeways to be established, bicyclists must be considered more closely.

PURPOSE OF THE STUDY

The purpose of this study is to examine college student bicycle route selection process, focusing upon the factors in that process and their variability. This study assumes that the routes taken by college students are the result of a route selection process whose components can be identified. The purpose of this thesis is to answer the following five questions: (1) What factors are important in the selection of a route by a bicyclist?; (2) How do these factors vary with trip purpose?; (3) How do the factors vary with different socio-economic status?; (4) How do the factors vary with different types of bicycle users?; (5) How do the actual bike route choices vary from minimum distance paths?

The purpose of the first question is to identify key factors of bicycle

route selection that reveal what a route must possess in order for it to be taken by a bicyclist. The purpose of questions two, three, and four should be self explanatory. The fifth question examines the actual route behavior of the bicyclist as compared to minimum distance paths. If the actual path does vary from the minimum distance path, it is assumed that the other factors of bicycle route selection have a somewhat greater influence on the route selection. (The greater the difference between the actual route choices and the minimum distance paths, the more important the influence of the other factors become in the selection of a route.)

This study fits into the subfield of transportation geography as it investigates how different areas are linked in the urban landscape by the bicycle. The study of individual travel behavior within urban areas falls into the area of micromovement travel behavior as suggested by Hurst.[16] Micromovement studies look at individual travel motivations and patterns. Hurst discussed the notion of movement space (the perceived, felt, conceived part of the built environment within which movement occurs or about which some conception is held) in the context of Roger Downs' three major perception-behavioral approaches (structural, evaluative, and perference) to analyze movement space.[17] My study follows the evaluative approach as it focuses upon factors people consider important in their perceived worlds and how these factors affect route decisions. Although this thesis emphasized an evaluative approach, the other approaches

provide us with some 'epistenological' props concerning the image of the transportation network and the built environment; what perceived factors affect model or route choices; and how the final destination point is chosen.[18]

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[16]Michael E. E. Hurst, Transportation Geography: Comments and Readings, (New York: McGraw-Hill Book Company, 1974), pp. 501-503.

[17]Ibid.

[18]Ibid.

This thesis looks at the factors that compose the most efficient bike routes. The image of the transportation network is portrayed by all of the factors considered in the route selection process such as directness, speed of vehicles, condition of the road surface, and attractive scenery along the route.

This study is placed in the spatial tradition of geography which involves geometry and movement. The study of the paths which an individual selects from a network of possible routes has an inherently geometrical aspect, as does investigating the differences of bicycling behavior with different trip purposes. Movement involves both the time and spatial dimensions, both of which are integral to the concept of movement space. Movement is important because it may be influenced by the form and content of the space through which it occurs. By studying the movement space of the bicyclist and its geometrical implications, an understanding of bicycle behavior in the urban environment can be gained that will be helpful in the development of a more effective bikeway system.

Geography is interested in human spatial interaction and additionally the processes that promote interaction. The bicycle is a vehicle of spatial interaction, its routes connect different areas of the urban landscape. If in the form of bikeways, the routes have a slight impact on the form and shape of the urban landscape. Lowe and Moryodes stress in their text, The Geography of Movement, that geographers should investigate the modes that add new shape and form to urban areas no matter how large a role they play in the urban transportation system.[19]

My study can also be traditionally justified. Geographers have previously studied the development, impact, and the routes of the different modes.[20]

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[19]John C. Lowe and S. Moryodes, The Geography of Movement, (Boston: Houghton Mifflin Company, 1975), p. 295.

[20]Ibid., p. 17.

METHOD OF APPROACH

The research for this thesis was conducted in the city of Manhattan, Kansas. Manhattan is predominately a college oriented community and any results and conclusions of this study should be placed in that context.

The research methodology was completed in four steps. The first step was an extensive review of the literature dealing with individual route selections in order to identify a list of factors that influence route selection. The factors that were uncovered will be discussed in the next chapter. A concentration in the study of pedestrian route behavior was used to reveal some relevant factors that can be applied to the bicyclist as the pedestrian is exposed to similar environmental threats.

The second step focused on a survey which was used to obtain a measurement of importance for the factors under study. (Chapter 3) In addition to the factors listed on the survey, the respondents were allowed to add any factors that they considered to be important. This step included the respondent's rankings of the most important factors associated with a particular trip purpose such as school, shopping, or personal business.

The third step involved the analysis of the survey results. Specifically, factor variability with socio-economic status, trip purpose, and type of cyclist were tested. (Chapter 4)

The fourth step utilized a blank map survey, The bicyclist was asked to map out the routes of any trip or combination of trips that had been taken in the last month. A comparison between the actual paths taken and minimum distance paths was conducted. It was assumed that as the difference between actual path distances and minimum distance increases, the role of route selection factors other than distance become more important, Ideally minimum time is preferred over minimum distance; however, the variability of cycling time among individuals prohibits using time here. The minimum distance path was calculated from the most direct route to the destination, whose distance

was measured from the scale of the map. The distance for the actual route taken was determined in a similar manner.

Chapter II

A LITERATURE REVIEW OF ROUTE SELECTION BEHAVIOR

INTRODUCTION

The Federal government through the Federal Highways Act of 1973 set aside funds for the development of bikeways, while California and Oregon allocate part of their gasoline tax funds for bikeway construction. This funding was a response to the increasing demands placed by bicyclists upon the already congested and dangerous transportation systems. Separate facilities (bikeways) were being desired by concerned bicyclists and transportation planners in order to incorporate the bicycle more effectively into transportation systems.[1] The recent availability of funds for bikeways has generated a request for studies dealing with the importance of the bicycle as a mode of urban transportation and the processes by which bicyclists select their routes in the urban environment. Most of the studies available have been completed by state planning agencies for cities that desired to integrate the bicycle more actively and efficiently into their transportation networks. Many of the publications are government studies, while a few academic efforts exists.

BIKEWAY DESIGN AND SAFETY

Most research on bicycle transportation has focused on the engineering aspects of constructing bikeways. The publications have concentrated on safety and design requirement, while rarely considering the way cyclists select routes. Some of the more widely known publications include: The

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[1] Carl E. Ohrn, "Estimating Potential Bicycle Use and Public Investment" (Paper Presented at the 43rd Annual Meeting of the Institute of Traffic Engineers, Los Angeles, April, 1972); David T. Mason, "Financing Bikeways, Another Viewpoint," Bicycling, January 1975, p. 21; Richard C. Podolske, "Investing in Urban Bicycle Facilities," Transportation Engineering, Vol. 100, TE3, August 1974, p. 687-700.

U.S. Department of Transportation's reports - Safety and Locational Criteria for Bicycle Facilities,[2] and Safety And Locational Criteria For Bicycle Facilities: User Manual Vol. 1 and 2,[3] and Oregon State Highway Division - "Bikeway Design",[4] and "Footpaths and Bike Routes",[5] University of California - Bikeway Planning Criteria and Guidelines,[6] and the University of Florida - "Guidelines for Bikeway Systems".[7] These studies stress design criteria, safety requirements, the planning process, locational criteria, potential users, and travel characteristics such as trip length, trip purpose, and trip numbers.

BICYCLE AS A MODAL CHOICE

The role of the bicycle as a viable mode of urban transportation has been discussed in detail by transportation planners, engineers, and in several studies by the Environmental Protection Agency (EPA). Articles such as: "The Bicycle Anarchy,"[8] "The Bicycle As A Mode of Urban Transportation."[9] "Bicycling

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[2] D. T. Smith, Safety and Location Criteria For Bicycle Facilities, U.S. Department of Transportation, Federal Highway Administration Report No. FHWA-RD-75-112 (Washington, D.C.: U.S. Government Printing Office, 1975).

[3] D. T. Smith, Safety & Locational Criteria for Bicycle Facilities User Manual Volume I: Bicycle Facility Location Criteria and Volume II: Design and Safety Criteria, U.S. Department of Transportation, Federal Highway Administration Reports No. FHWA-RD-75-113 + 114 (Washington, D.C.: U.S. Government Printing Office, 1976).

[4] Oregon State Highway Division, "Bikeway Design," January 1972 (pamphlet)

[5] Oregon State Highway Division, "Footpaths and Bike Routes," January 1972 (pamphlet)

[6] University of California, Bikeway Planning Criteria and Guidelines (Los Angeles: University of California Press, 1972).

[7] University of Florida, "Guidelines for Bikeway Systems," 1974 (Xerox)

[8] James Konski, "Bicycle Anarchy," Transportation Engineering, Vol. 99 TE4, November 1973, pp. 757 +.

[9] Jason Yu, "The Bicycle as a Mode of Urban Transportation," Traffic Engineering, Vol. 43, No. 12, September 1973, pp. 35-8.

For Commuting and Recreation,"[10] and "Pedal-Power Urban Bike Commuting"[11] appeared in late 1970 and early 1971 in popular magazines such as The New Yorker[12] and Newsweek.[13] In 1973 articles started to appear in journals like Parks and Recreation,[14] Transportation Engineering,[15] American City,[16] and Traffic Quarterly.[17] A more detailed publication by the EPA, Bicycle Transportation,[18] summarizes most of the early studies and contains a compedium of information on the role of the bicycle as a means of urban transportation. The advantages and disadvantages of bicycling were discussed in most of the articles. Unfortunately, none of these studies examined the routes taken by bicyclists and how those routes were selected by the bicyclists. I found nothing by geographers that dealt with the examination of bicycle route behavior.

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[10] "Bicycling For Recreation and Commuting," U.S. Department of Transportation and U.S. Department of Interior, (Booklet, 1973).

[11] R. Hanneman, "Pedal-Power Urban Bike Commuting," Parks and Recreation, Vol. 6, January 1971, pp. 28-33.

[12] "Bike to Work," New Yorker, Vol. 46, September 26, 1970, p. 28.

[13] "Bike Boom: A Way Out for Commuters," Newsweek, Vol. 71, December 6, 1971, pp. 84-85.

[14] B. W. Porier, "Researchers Report Highlights of Bicyclist Survey Analysis," Parks and Recreation, Vol. 8, November 1973, pp. 62-3.

[15] Vincent R. Desimone, "Planning Criteria for Bikeways," Transportation Engineering, Vol. TE3, August 1973, pp. 609-625.

[16] "Bikeway Design Provides New Challenge for Cities," American City, Vol. 88, May 1973, p. 86.

[17] Michael Everett, "Commuter Demand For Bicycle Transportation in the U.S.," Traffic Quarterly, Vol. 28, October 1974, pp. 585-601.

[18] Nina Dougherty and William Lawrence, Bicycle Transportation, U.S. Environmental Protection Agency, Office of Planning and Evaluation, (Washington, D.C.: U.S. Government Printing Office, 1974).

PEDESTRIAN ROUTE SELECTION

The pedestrian functions under a similar set of environmental contingencies as the bicyclist. For example, they both experience safety threats and weather hardships. Therefore, studies of the factors of route selection of the pedestrian could be helpful in formulating a set of factors of route selection that could be applied to the bicyclist. A literature review of pedestrian studies revealed many factors that can be evaluated by the bicyclist and many are included in the survey used in this study. (Appendix A)

The routes of the pedestrian have been studied in detail in numerous articles in conjunction with the design of facilities for pedestrians. It is important to note that pedestrians make use of a more complex and integrated network of paths than other modes of transit, and their route selection behavior is very difficult to model as the assumptions that other modes of transportation are based upon do not hold for pedestrian behavior. For example, the intricacies of pedestrian flow on which CBD land value and landuse partially depend are not yet fully understood at the micro-level of vehicular traffic flow.[19] Pedestrian route selection models are also complicated in that pedestrians can cross in the middle of a block, reverse their direction of travel with ease, and navigate through buildings.

The work by geographers was stimulated by Hurst's paper on micromovement and movement space as it formed a base for the study of human pedestrian spatial behavior within urban areas.[20] It also established the basic approaches used in answering the questions asked in this thesis, (Chapter 1) This study was followed by a more detailed analysis by Westalius.[21] Westelius concluded

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[19] Michael Hill, "Pedestrian Behavior in an Urban Environment" (Paper Presented in May 1975 at the Nebraska Academy of Sciences).

[20] Ibid.

that pedestrian behavior was due to the following factors; individual needs, the spatial and temporal location resources, and the individual's average time budget.[22] Those factors can be used to chart an individual's position in movement space. Although this study does not directly apply to my thesis, it does show how individual behavior in urban areas can be measured and investigated.

Mike Hill has pointed out that the three key areas of pedestrian behavior for future study are trip purpose, available time, and the perception of the environment through which the pedestrian travels (the aesthetic qualities of the environment).[23] In his study, Hill examined the paths taken by pedestrians, attenption to map out their route behavior. The article also provided a background on the development of pedestrian route behavior in the field of geography. Hill's bibliography on pedestrian behavior revealed how much and what kind of work has been done in the area of pedestrian route selection and provided a base from which studies of pedestrian route behavior and factors of pedestrian route choice could be drawn for my study.[24]

Morris and Zisman, in studying the pedestrian in the CBD, stressed that the choice of routes by individual pedestrians was governed by the factors of time, familiarity, objectives, convenience, safety, and attractiveness of the routes. While the previous studies dealt with the mapping and modeling of pedestrian route behavior, this one investigated the factors that influence the selection of one route over another. Morris and Zisman stated that the pedestrian tended to maintain a general direction of movement, avoid street crossings, avoid alleys or other passageways, to use private ways or uncongested

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[22] Ibid.

[23] Hill, op. cit.

[25] Ibid

areas, or routes that offer a maximum of convenience in stops.[25] Pedestrians were noted as usually taking the shortest routes, but the other factors when considered changed the choice of the routes to longer paths. My study will investigate this behavior as it pertains to the bicyclist.

Blivice used 24 factors to describe the routes taken by pedestrians.[26] The factors fell into the following general categories: the type and condition of the path itself, the views and scenery along the route, disturbances created by the movement of vehicular traffic along the path, type of vegetative cover present, and the types of activities found along the routes. All were used to analyze the routes taken by pedestrians. Pedestrians were found to desire routes that were separated from vehicular traffic with a preference for short and quiet routes, along with plenty of greenery and displays. Lautso and Murole also had findings that supported the conclusions of Blivice's study. They found that the pedestrian environment should have tranquility, trees and plants, atmosphere, and colorfulness.[27]

All of these studies investigated the route behavior of the pedestrian in urban areas and the factors that influence the selection of a particular route. The Morris and Zisman study was very general as it did not concentrate on the factors of route selection, but on accommodating the pedestrian in the CBD.

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[25] Robert L. Morris and S. B. Zisman, "The Pedestrian, Downtown, and the Planner," Journal of the American Institute of Planners, Vol. 28 (3), August 1972, pp. 152-158.

[26] Sheldon M. Blivice, "Pedestrian Route Choice: A Study of Walking to Work in Munich" (unpublished Ph.D. dissertation, University of Michigan, 1974) Abstract.

[27] Karl Lautso and P. Murole, "A Study of Pedestrian Traffic in Helsinki: Methods and Results," Traffic Engineering and Control, Vol. 59 (9), January 1974.

Blivice's study investigated what factors a route must have in order for it to be used and the study detailed the types of factors that exist along a route. Blivice looked at the factors that function for pedestrian work trips while Lautso and Murole determined what factors make the environment of a route good or bad. These studies are related to this one because they investigated the factors of route selection as they pertain to the pedestrian, whereas this thesis is doing the same for the bicyclist.

The literature review revealed the advantages of the bicycle as a mode of urban transportation and what has been done to accommodate the bicycle onto the urban transportation system. It also revealed some shortcomings, like the lack of work in the study of the implications of bicycle travel and route selection within the urban transportation network. Bicycle user behavior in the urban environment needs to be investigated in order to help formulate a better planning procedure so that the bicycle can be placed more efficiently on the urban transportation network and so that the spatial patterns of the bicyclist's routes can be understood.

Chapter III

SURVEYING ROUTE SELECTION FACTOR IMPORTANCE

This chapter is divided into two parts. The first part discusses the content of the survey, its administration, and the characteristics of the respondents. The second part focuses upon the identification and prioritization of route selection factors by the respondents.

SURVEY

Survey Construction

A survey was the primary device used to gather information about the route selection process of bicyclists in Manhattan, Kansas. The survey construction was synthesized from other surveys used in research dealing with bikeway needs.[1] The questionnaire was designed to collect five types of information: bicycle user types, priority of route selection factors, factor variability with trip purpose, socio-economic status, and actual versus minimum distance paths.

The first component of the survey required the bicyclist to identify one of four user types he or she best fits. The user types were defiend in Chapter 1. These responses were used to determine route selection factor variability among user types.

The second part of the survey asked the bicyclists to measure the importance of the listed factors in their selection of a route. Likert scaling was used to determine the importance of the factors.[2] The survey used a seven point scale

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[1] "Bike Survey" (New York: Bicycle Institute of America, 1973), pp. 1-2, (Mimeographed); "Bicycle Survey (Ad Hoc Bicycle Safety Committee, KAFB First Term Airman Advisory Council, 1973), pp. 1-2, (Mimeographed); Don and April Stockard, "Bike Laws and Our Rights," Bicycling!, January 1974, pp. 41.

[2] C.A. Moser and G. Kalton, Survey Methods In Social Investigation, 2nd ed. (New York: Basic Books Inc., 1972), pp. 183-185.

from which the degree of importance was measured for each factor. A factor that had a great effect on the selection of a route was indicated by marking the last position on the righthand part of the scale, while a factor that had a very little effect was indicated by a mark on the far lefthand side of the scale. (Appendix A) Scores were assigned such that a value of one was considered least important, while seven was most important. In addition to the survey factors, the respondents were allowed to add any factors that they felt were important and these were also subjected to the integer scaling process.

Some of the listed factors were obtained from sources other than the literature review. For example, questionnaires provided by the Bicycle Institute of America and other bicycle studies included examples of route factors such as traffic and safety.[3] Other factors were obtained from bicyclists who were asked to look at a tentative list of factors and comment on the relevance of the factors or add any factors thay they felt should be included. The final list of factors is presented in Question 3 on the survey (Appendix A). Certainly the list is not inclusive, but it does contain a divergent set of the most relevant factors of bicycle route selection based upon a review of the literature, bicycle studies, and cyclists' responses.

To investigate the variability of the factors with trip purpose, the bicyclist indicated the most important factors that influence the selection of the route for different trips in part three. The variability of the factors for different bicycle user types and socio-economic status was investigated for each of the trip purposes.

The fourth part requested socio-economic information on the respondent to include; age, sex, education, and income. These were used to investigate the variability of factors between groups having different socio-economic status.

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[3] "Bike Survey," op. cit.

The last part was a blank map survey. The bicyclists were asked to plot the routes taken most frequently for specific trip purposes within the past month. This allowed a comparison of the minimum distance paths with the actual paths.

Survey Administration

Four methods were used to administer the survey. The methods included surveying bicyclists at the ends of purposeful trips, in transit, through bicyclists already contacted, and in 'captive' situations. These methods are discussed in the following paragraphs.

The survey was administered primarily to bicyclists, who were students at Kansas State University. The first contact was oral. The bicyclists were asked to complete the survey either at the time of contact or at their convenience. An attempt was made to contact the respondents at locations where they tended to collect such as the KSU Union, the KSU Library, stores, and other locations in the city of Manhattan. Unfortunately the respondents often had limited time and responded to the survey in a rapid fashion. This method was time consuming and proved too difficult for contacting a great number of bicyclists.

The above survey technique missed two important types of bicyclists - recreational users and non-student adult cyclists. To obtain some responses from those groups, cyclists were contacted in transit. One drawback of this method was that the other user types were identified with the recreational users. This method was also time consuming and permitted only a few contacts. Both methods combined yielded only 20 usable surveys in a period of 3 weeks.

Another method utilized, was to ask bicyclists who were contacted through the above methods if they had friends who were also bicyclists and would complete the survey. If so, they were given surveys to be completed and returned by their friends. This method functioned well as it provided some

carefully completed surveys. Thirty-five surveys were distributed and 20 were returned.

The problems associated with the first three methods suggested a change in survey methods to one involving a "captive" population, a population that was clustered in a group such as a class. In such cases time was not a limiting factor, permitting careful completion of the survey. The survey was administered to the following classes at KSU: Natural Resources for Leisure, World Regional Geography, Introduction to Planning, and Environmental Geography. Only bicyclists were allowed to complete the survey. Forty in-class surveys were completed by the Natural Resources For Leisure and the Environmental Geography classes. In the World Regional Geography and Introduction to Planning classes the return rate was very poor as 42 surveys were distributed, but only 7 were returned. As a whole, the surveys returned by this method seemed thoroughly completed.

In an attempt to isolate non-student adult bicycle users, part of the survey was conducted away from the influence of the University during Spring Break. It attempted to reach the recreational bike user. The goal of reaching the non-student adult and recreational bicycle users was achieved by presenting the survey to the University for Man Bicycle Repair Class and to the Bluemount Bicycle Club. Some students were reached through this method, but more adults were reached as were many recreational and bike buff users. Thirty-five completed surveys were obtained by this method.

The survey was conducted during the month of March at a time when the population of bicyclists was at or near its peak, The survey month can be further justified due to the increase and variety of recreational and outdoor activities that are associated with improving weather conditions. Another good reason for surveying in March was that the weather at this time of the year was quite variable, better enabling bicyclists to compare the environmental factors that affect their route selection behavior. The weather

ranged from bright clear warm days to cloudy dreary days with sleet and snow.

Respondent Characteristics

The research data used was obtained from 122 usable surveys. Table 1 presents a summary of the sample characteristics. The sample contained a majority of males (70.5%) The age characteristics reflect the influence of the student bicyclists, as those aged 29 and younger accounted for 90.2% of the sample. Due to the lack of sufficient numbers of respondents in the 30-39, 40-49, and 50 and older age groups, the 30 and older age group was formed. This group contained only 9.8% or 12 respondents,

The education characteristic indicated that all respondents completed at least some college, while 18 respondents had completed college and 12 had at least some graduate school.

The distribution of respondents among the family income categories was quite even. The most respondents occurred in the $15,000 to $25,000 income group (26.3%). The least number of respondents were in the $7,000 to $12,000 group (16.4%).

The casual user was the most popular user type (47.5%). The utility user accounted for 28.7%, while those that considered themselves real bicycle buffs numbered 18 (14.8%) and only 11 (9%) respondents had no alternative to bicycling or walking as a mode of transit.

As noted in Chapter 1, the ten speed bicycle is the most popular form of the bicycle today. This holds true with my sample as 102 respondents (83.6%) used ten speed bicycles. The five speed was next in popularity (7.4%) followed by three speed bicycles (6.6%) and single speed bikes (2.5%).

To generalize on the nature of the sample it should be noted that it was predominantly male between 20 to 29 years of age and with some college having been completed. The income of the sample did not have a dominent trend as the respondents were distributed evenly among all income ranges. Most of the

Table 3-1

RESPONDENT CHARACTERISTICS

Index	Number	Percentage
Sex:		
Male	86	70.5%
Female	36	29.5%
Age:		
Less than 20	30	24.6%
20 to 29	80	65.6%
30 and older	12	9.8%
Education:		
Some college	82	67.2%
College graduate	18	14.8%
Some grad and grad school graduate	22	18.0%
Family Income:		
Less than $7,000	23	18.9%
$7,000 - $12,000	20	16.4%
$12,000 - $25,000	24	19.7%
$15,000 - $25,000	32	26.2%
$25,000 and up	23	18.9%
User Types:		
Bike - Walk	11	9.0%
Casual	58	47.5%
Real Buff	18	14.8%
Utility	35	28.7%
Bike Types:		
Single Speed	3	2.5%
Three Speed	8	6.6%
Five Speed	9	7.4%
Ten Speed	102	83.6%

Source: Compiled by author.

bicycle users were casual users who used the bicycle primarily for recreational purposes, although a significant number of utility users were surveyed.

IMPORTANCE OF ROUTE SELECTION FACTORS

Factor Identification

This study attempts to identify the priority of factors that a bicyclist considers important in the selection of a route. More specifically, the variability of route selection factors with different trip purposes, user types, and socio-economic status were examined. The factors were obtained from the literature review, personal responses, and previous studies. The literature review identified the range of factors for route selection. Most of the factors apply to many modes, but may also be applicable to the bicyclist. Many relevant factors were obtained from studies of pedestrian behavior. As the bicyclist is subjected to similar environmental and physical threats as the pedestrian, both should consider similar factors of route selection. Both are exposed to the impact of temperature and wind, and both provide the physical work necessary to move about the urban environment.

The route selection factors can be placed into four categories: traffic conditions (number, speed, and type of vehicles present); road conditions (grade and road surface); environmental conditions (weather, noise, and air quality); and personal factors (concern for safety, time budget, and others). The categories depict the environment through which the bicyclist travels and were used to determine what makes one route more desirable than another.

Measuring the Importance of Route Selection Factors

The respondents were asked to ordinally scale the 18 route selection factors listed in Question 3 (Appendix A). These scales led to a general understanding of what factors a bicyclist perceives as important in the selection of a route. The variability of the factors among the different

characteristics will be discussed in detail in a later chapter.

The mean values were calculated for each of the factors. The mean values were computed by taking the values assigned to each of the positions on the scale for a factor and summing them. This value was then divided by the frequency by which that factor was scaled. The Cross-Break program cross tabulated the information into the different user characteristics so that the means of each factor with each of the user characteristics could be determined.[4]

On the seven position scale on the survey, a value of 7 indicated a factor had the maximum possible effect on route selection, while a value of 1 suggested a factor had the minimum possible effect. A value of 4 means that a factor had a moderate effect. The values were ranked from the highest mean to the lowest mean (Table 2).

In term of mean value, the most important factor was weather (5.17), followed in order by the condition of the road surface (4.83); accident potential (safety) (4.74); number of heavy vehicles (4.70); wind velocity and direction (4.67); number of vehicles (4.63); attractive scenery along the route (4.58); temperature (4.47); and the speed of the vehicles (4.41). The factors that were least important in the selection of a route by a bicyclist and their mean values included: number of pedestrians (2.37); number of stop signs (2.54); amount of cross traffic (3.49); and noise and air quality (3.84).

The priority list of factors that effect route selection by bicyclists concentrated in the environment, traffic, and road condition categories. It was expected that the traffic and road conditions variables would be ranked high, but surprising were the high rankings of the weather and weather related

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[4] Norman H. Nie and others, Statistical Package For The Social Sciences (SPSS), Second Edition, (New York: McGraw-Hill Book Company, 1975), pp. 249-264.

Table 3-2

AVERAGE FACTOR MEANS AND RANKINGS

Factors	Mean	Rank
Weather	5.17	1
Condition of road surface	4.83	2
Accident potential (safety)	4.74	3
Traffic (number of heavy vehicles)	4.70	4
Wind velocity and direction	4.67	5
Traffic (number of vehicles)	4.63	6
Attractive scenery along route	4.58	7
Temperature	4.47	8
Traffic (speed of vehicles)	4.41	9
Darkness/light	4.37	10
Directness	4.16	11
Time necessary to complete trip	4.08	12
Steepness of grades	3.95	13
Distance	3.94	14
Noise and air quality	3.84	15
Amount of cross traffic	3.49	16
Number of stop signs	2.54	17
Number of pedestrians	2.37	18

Source: Compiled by Author from Cross-Tabs Computer Run.

factors (temperature and wind). Although they play a major role in modal choice and were not expected to play a major role in route selection once the bicycle had been chosen. Accident potential (safety) was the only personal factor ranked in the top ten factors. Surprisingly low were the rankings of pedestrians, stop signs, and cross traffic. It was interesting to note that distance, time, and directness were ranked as not very important in the selection of a route.

It can be concluded that the bicyclists' routes were largely determined by weather and road conditions, along with the amount, speed, and type of vehicular traffic. A desirable route would possess attractive scenery and be safe as these also were important factors in the selection of a route.

These general conclusions will be tested for subpopulations in the next chapter as the variability of the factors with user types and trip purpose will be investigated.

Chapter IV

ROUTE SELECTION FACTOR VARIABILITY

Do the route selection factors change with different trip purposes and different user characteristics. This key question will be answered in this chapter. This chapter analyses the factor variability for all trip purposes by user types and socio-economic characteristics (age, sex, education, and income), factor variability between the different trip purposes, factor variability for specific trip purposes by user types and socio-economic characteristics, The differences in route selection factor rankings will be investigated in the above cases with the techniques described in the following methodology section. The comparison of actual route distance to minimum route distance will be the concluding section of this chapter.

METHODOLOGY

The methodology used in the investigation of factor ranking variability between different respondent components involved five steps: (1) the determination of factor ranks for all respondent groupings, (2) the use of Spearman's ranked-order correlation coefficients to determine factor variation between two groups of factor rankings, (3) use of a t test to determine if the correlation is significantly different from zero, (4) a discussion of the correlation coefficients meanings for paired combinations of respondent groups, and (5) a test for significant difference between different correlation coefficients.

The factor rankings were determined by two methods. The first method used data from Question 3 (Appendix A) that described the factors that functioned for all trip purposes. The respondents ordinally scaled the 18 route selection factors listed in the question according to the effect they had on route selection. The Cross-Break Program cross tabulated the information into

the different user characteristics so that the means of each factor for respondents having specific user characteristics could be determined.[1] The mean values were computed by taking the values assigned to each of the positions on the scale for a factor and summing them. This value was then divided by the frequency of respondents in the pertinent groups. The factors were ranked from the highest mean to the lowest mean for each of the respondent characteristics. (Tables B-1 to B-6, Appendix B) These factor rankings were used to investigate factor variability among user types, age groups, sex, education groups, income groups, and between trip purposes.

The second method of factor ranking used the information obtained from Question 4 of the survey (Appendix A). The respondents ranked the top five route selection factors for specific trip purposes. This was different from the first ranked factors which were based upon mean scale values for all trips, in that second method ranks for specific trip purposes were obtained. The raw survey data was compiled using the Cross-Tabs Computer Program. Cross-Tabs places raw data into tables specified by the researcher. Cross-Tabs generated a series of tables delimiting the frequencies of ranks assigned to each factor for the different respondent groups from information obtained from Questions 1, and 5 to 8 (Appendix A.)[2] An index was used so that a factor could be ranked based upon the number of times it was listed first, second, third, fourth, and fifth in Question 4 (Appendix A). The index was computed as follows: The frequency that a factor was ranked first was multiplied by five; the frequency that it was ranked second was multiplied by four; and so on. The index values for each factor were totaled to compute the final index of factor importance.

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[1] Norman H. Nile and others, Statistical Package for The Social Sciences (SPSS), Second Edition (New York: McGraw-Hill Book Company, 1975), pp. 249-264.

[2] Ibid., pp. 218-245.

The factor with the highest total was ranked first and the factor that had the lowest total was ranked last (only the 18 listed factors were used due to the infrequency with which the respondents added factors). The factor rankings were cross tabulated for each trip purpose by user types and socio-economic characteristics to investigate the variability of the factor rankings. (User types and socio-economic characteristics were obtained from Questions 1 and 5 to 8). Tables B-7 to B-36 contain the rankings of the factors for each of the purposes by user type and socio-economic characteristics. (Appendix B).

General trip (all trips) factor ranking variations were examined for groups defined by user type, age, sex, education, and income characteristics combinations. The between group factor relationships investigated for each specific trip purpose (recreation, work, shopping, school, health, and personal business) are the same as those for all trips.

Factor ranking associations between groups were investigated using the following techniques. Spearman's rank correlation coefficients were used to test the degree of association route selection factor rankings between two respondent groups. Spearman's ranked correlation coefficients were computed with the following equation:

$$r_s = 1 - 6 \frac{\sum_{i=1}^{N} d^2}{N^3 - N}$$ [3]

Where:

r_s = the correlation coefficient for the case under study

d = the difference between the ranked factors

N = the sample size

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[3] William Mendenhall, Lyman Ott, and Richard H. Larson, Statistics: A Tool For The Social Sciences (North Scituate, Massachusetts: Duxbury Press, 1974), pp. 372-375.

A value of +1.0 indicated that the rankings were in perfect agreement, while a -1.0 indicated that they were in perfect disagreement, and a zero indicated they had no relationship whatsoever,[4] The correlation coefficients describe the amount of similarity or variation between sets of ranked factors. Spearman's rank-order correlation coefficient measure the strength of the relationship between the sets of ranks. The correlation coefficient can be converted to r^2 value which would indicate the percent of explained variation within the sets of ranked factors. For example, a correlation coefficient of .50 could be converted to an r^2 value of .25 which indicated that one of the sets of ranked factors explains 25% of the variation contained within the other set.

The correlation coefficients were than tested to see if they varied significantly from zero. To do this the following t test was used:[5]

$$t = r_s\sqrt{\frac{N - 2_2}{1 - r_s}}$$

Where:

t = t value (score)

r_s = the correlation coefficient being tested

N = the sample size

For sixteen degrees of freedom and a significance level of 95%, a critical value of ± 2.12 was established. Significant correlation coefficients are asterisked in the relevant tables. The variability of route selection factor importance between different groups and trip purposes is suggested by the correlation coefficient. For example a r = +.90 indicates little variability while a value of r = +.26 indicates substantial variability.

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[4] Ibid.

[5] Ibid., p. 373.

Significant differences between different correlation coefficients can also be tested. For example, assume the r value expressing the correspondence between group x and y ranks of the important route selection factors is .83, while the r for groups x and z is only .52. Is the disagreement between x and z really significantly greater than that for x and y? The significance of the difference is statistically testable as follows:

(a) For the cases in which the correlation were based upon independent samples (no variable was shared by both correlations), the correlation coefficient values had to be transformed into z values.

First the standard error had to be calculated:

$$\sigma_{z_1-z_2} = \sqrt{\frac{1}{N_1-3} + \frac{1}{N_2-3}} \quad 6$$

Where:

$\sigma_{z_1-z_2}$ = the standard error

z_1 = z value for r_1

z_2 = z value for r_2

N_1 = number of cases for r_1

N_2 = number of cases for r_2

This was then used in the following equation:

$$Z = \frac{(z_1-z_2) - 0}{\sigma_{z_1-z_2}} \quad 7$$

Where:

Z = the Z score to be tested for significance

z_1 = z value for r_1

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[6] Hubert M. Blalock, Jr., Social Statistics, Second Edition (New York: McGraw-Hill Company, 1972), p. 406.

[7] Ibid.

z_2 = z value for r_2

$\sigma_{z_1-z_2}$ = the standard error

The Z value was then found in the normal table to check if the two correlations being examined were significantly different from each other. If yes, a "YES" is found on the relevant table. This tells if a correlation is significantly stronger or weaker than the correlation with which it was compared.

(b) For cases in which there was a single dependent sample (all of the relationships had a similar dependent variable), the correlation coefficient value had to be converted to a t value using the following equation:

$$t = (r_{xy}-r_{zy}) \sqrt{\frac{(N-3)\ (1+r_{xz})}{2\ (1-r_{xy}^2 - r_{xe}^2 - r_{yz}^2 + 2r_{xy}r_{xz}r_{yz})}} \quad [8]$$

Where:

r_{xy} = correlation coefficient for variables z and y

r_{zy} = correlation coefficient for variables z and y

r_{xz} = correlation coefficient for variables x and z

N = sample size

If the t value was found to be significant, then the correlations were significantly different from each other indicating a stronger or weaker similarity in the correlations involved.

FACTOR VARIABILITY FOR ALL TRIP PURPOSES BY USER TYPES

The variability of factor rankings for all trips among user types and socio-economic groups is examined first.

The top factors of bicycle route selection for each user type can be

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[8] Ibid., p. 407

discerned in Table B-1 (Appendix B). Table 1 presents the correlation coefficients for rankings of paired combinations of user types. In order to simplify sentence structure and the discussions of the different user types, the following abbreviations are used: BW (bike/walk only); C (casual); BB (bike buff); and U (utility). The BW-C correlation (.8354) stands out as indicating that the factor rankings for these groups were more similar than those of any other combinations of user types, All of the correlations were significantly different from zero, but the other user type combinations had surprisingly lower values (.5232 to .6011), which indicated that some similarity existed, but also that more variation existed between the groups' route factor selection processes. The BW-C correlation coefficient was significantly different from the other correlations. (Table 2) This suggests that statistically the route factor agreement for the BW-C comparison was significantly more positive than the associations for other user combinations. The remaining correlations were not significantly different from each other. (Table 2) In general, there was a significantly positive association between rankings for all group comparisons.

FACTOR VARIABILITY FOR ALL TRIP PURPOSES BY SOCIO-ECONOMIC CHARACTERISTICS

The factor rankings for all trip purposes by socio-economic characteristics are presented in Tables B-2 - B-5 (Appendix B).

Factor Variation For All Trip Purposes By Age

The thirty and older age group had a different route selection process than the other two age groups as it correlated very low with them. The correlation coefficients were .3550 for under 20 and 30 - older and .3372 for the 20-29 and 30 - older age groups. The values were not significantly different from zero. On the otherhand, the under 20 and 20 to 29 year correlation coef-

Table 4-1

CORRELATION OF ROUTE SELECTION FACTOR RANKINGS OF ALL TRIP PURPOSES BY USER TYPES

	Bike Only	Casual	Bike Buff	Utility
Bike only		.8354*	.5232*	.5397*
Casual			.5289*	.5289*
Bike Buff				.6011*
Utility				

Source: Compiled by Author.

Table 4-2

SIGNIFICANT DIFFERENCE BETWEEN CORRELATION COEFFICIENTS FOR USER TYPE COMBINATIONS

	BW-C	BW-BB	BW-U	C-BB	C-U	BB-U
BW-C		yes	yes	yes	yes	yes
BW-BB			no	no	no	no
BW-U				no	no	no
C-BB					no	no
C-U						no
BB-U						

Source: Compiled by Author. (BW-Bike/Walk only; C-Casual; BB-Bike Buff; U-Utility)

ficient (.7807) was significantly different from zero suggesting that similarity did exist between the two groups. The lower correlations significantly differed from the .7807 correlation, establishing that 30 and older group did have a significantly different route selection factor behavior. The under 20 and 20-29 groups had similar factor selection as their values did not differ significantly from each other. (Tables 3 and 4)

Factor Variation For All Trip Purposes By Sex

Males and females had similar route selection factors as they had a high correlation coefficient (.7657).

Factor Variation For All Trip Purposes By Education

In order to simplify the references to the different education groups the following abbreviations were used: SC (some college); C (college); and SG (some graduate/graduate). All of the correlations were significant from zero as the values ranged from .5779 to .7905. (Table 5) The SC-C correlation (.7905) had the highest degree of similarity. This correlation was significantly different from the correlation of SC-SG (.5779). The other correlations were not significantly different from each other. (Table 6) In conclusion, only minor differences exist between education groups in their route factor selection behavior, although in one case there was significant differences between the SC-SG and the SC-C correlations.

Factor Variation For All Trip Purposes By Income

The correlation coefficients ranged from .5879 ($0 to $7,000 and $7,000 to $12,000) to .9282. All of the correlations were significant from zero which indicated that similarity did exist in varying degrees for each of the group combinations. The .9282 was a strong relationship indicating very little variability existing in the factor selection for the groups involved. This

Table 4-3

CORRELATION COEFFICIENTS FOR AGE GROUP COMBINATIONS

	Under 30	30 - 39	30 and older
Under 20	———	.7807*	.3550
20 - 29	———	———	.3372
30 and older	———	———	———

Source: Compiled by Author.

Table 4-4

SIGNIFICANT DIFFERENCE BETWEEN CORRELATION COEFFICIENTS FOR AGE GROUP COMBINATIONS

	Under 20-20-29	Under 20-30 and older	20-29 - 30 and older
Under 20 - 20 to 29	———	yes	yes
Under 20 - 30 and older	———	———	no
20 to 29 - 30 and older	———	———	———

Source: Compiled by Author.

Table 4-5

CORRELATION COEFFICIENTS FOR EDUCATION GROUP COMBINATIONS

	Some College	College	Some Grad/Grad
Some College	———	.7905*	.5779*
College	———	———	.6640*
Some Grad/Grad	———	———	———

Source; Compiled by Author.

Table 4-6

SIGNIFICANT DIFFERENCES BETWEEN CORRELATION COEFFICIENTS FOR EDUCATION GROUP COMBINATIONS

	S,C./C	S.C./S.G.	C./S.G.
S,C,/C	———	yes	no
S.C./S.G,	———	———	no
C./S.G.	———	———	———

Source: Compiled by Author. (S.C.-Some College; C-College; S,G.-Some Graduate/Graduate School.)

correlation varied significantly from all of the other correlations (except .8307 and ,8379). This meant that there were differences within the population as different groups had more variability in their factor selections. (Tables 7 and 8)

Summary: Factor Variations For All Trip Purposes

The general factor selection behavior of the different user types was similar, although the route factor selection behavior of BW when compared to the casual user behavior had a very strong relationship (almost perfect), that was was significantly different from the lower correlation values of the other groups. This indicated that differences in factor selection did occur, but similarity still existed between the different groups. BW-C users had the most similar factor selection, with BW-BB having the most variation in factor selection.

The general route factor selection of each age group shows that those aged thirty and older had a different ranking of factors than the other two age groups. The 30 and older group ranked the following factors: condition of the road surface, traffic (number of vehicles and heavy vehicles), attractive scenery along route, and accident potential (safety). The other groups had similar factor selection and stressed weather, wind velocity and direction, temperature, traffic (number of heavy vehicles), traffic (speed of vehicles), condition of road surface, and attractive scenery along route. Sex makes no difference in factor selection as only minor variations exist. Variations in factor selection exist in the education groups with some of the cases, but some degree of similarity exists between all of them. The SC-C comparison had the greatest similarity in route factor selection, with the SC-SG comparison having the most variation in factor selection. All of the income groups had similar factor selection rankings with the $0 to $7,000-$7 to $12,000 correlation having the greatest among of variation while the $15 to $25,000-$25,000

Table 4-7

CORRELATION COEFFICIENTS FOR INCOME GROUP COMBINATIONS

	0-7	7-12	12-15	15-25	25
0-7	___	.5879*	.6563*	.7095*	.6795*
7-12			.6886*	.8307*	.8379*
12-15				.7709*	.6852*
25 and older					.9282*
25 and older					

Source: Compiled by Author. (Income expressed in thousands of dollars)

Table 4-8

SIGNIFICANT DIFFERENCES BETWEEN CORRELATION COEFFICIENTS FOR INCOME GROUP COMBINATIONS

	0-7 / 7-12	0-7 / 12-15	0-7 / 15-25	0-7 / 25→	7-12 / 12-15	7-12 / 15-25	7-12 / 25→	12-15 / 15-25	12-15 / 25→	15-25 / 25→
0-7 / 7-12	____	no	no	no	no	yes	yes	no	no	yes
0-7 / 12-15		____	no	no	no	no	no	no	no	yes
0-7 / 15-25			____	no	no	no	no	no	no	yes
0-7 / 25→				____	no	no	no	no	no	yes
7/12 / 12-15					____	no	no	no	no	yes
7-12 / 12-15						____	no	no	no	no
7-12 / 25→							____	no	no	no
12-15 / 15-25								____	no	no
12-15 / 25→									____	yes
15-25 / 25→										____

Source: Compiled by Author.

and over had the most similar factor ranking behavior.

FACTOR VARIATION BETWEEN TRIP PURPOSES

Instead of examining the variation of the factors for all trips with specific respondent characteristics, this section investigates the variability of the factors between trip purposes. (Table B-6) (Appendix B) Recreation trip factor rankings when correlated with the rankings for other trip purposes yielded the following results: recreation-work (.4195); recreation-shop (.4427); recreation-school (.4514); recreation-health (.9551); and recreation-personal business (.7389). The factor selection for recreation trips differed significantly from that of the work, shop, and school trips as the correlation coefficients were not significantly different from zero. Health and recreation trips were very highly correlated (.9551) indicating that the same priority of factors function in the route selection for those two trips. Recreation and personal business factors were also strongly associated. (Table 9) Recreation correlations with work, shop, and school were significantly different from the correlations with health and personal business. (Table 10)

The work trip factors were very highly correlated with shopping factors (.9195), school factors (.9458), and personal business factors (.8240). Those correlations were significantly different from zero. The work trip factors varied significantly from the health trip factors, as indicated by their correlation value (.4257).

The shopping trip factor rankings were highly associated with the factor rankings for school, health, and personal business trips although the correlation coefficient with health (.5206) was significantly different from the correlations with school (.8612) and personal business (.7792).

School trip factors compared well with personal business factors (.8235). Differences in factor selection did occur with school and health trip factors

Table 4-1

CORRELATION COEFFICIENTS BY TRIP PURPOSE

	Recreation	Work	Shop	School	Health	Personal Business
Recreation		.4195	.4427	.4514	.9551*	.7389*
Work			.9195*	.9458*	.4527	.8240*
Shop				.8612*	.5206*	.7792*
School					.4799	.8235*
Health						.7853*
Personal Business						

Source: Compiled by Author.

Table 4-10

SIGNIFICANT DIFFERENCE BETWEEN TRIP PURPOSE CORRELATION COEFFICIENTS

	R-W	R-Sh	R-Sc	R-H	R-P	W-SH	W-Sc	W-H	W-P	Sh-Sc	Sh-H	Sh-P	Sc-H	Sc-P	H-P
R-W		NO	NO	YES	YES	YES	YES	NO	YES	YES	NO	YES	NO	YES	YES
R-Sh			NO	YES	YES	YES	YES	NO	YES	YES	NO	YES	NO	YES	YES
R-Sc				YES	YES	YES	YES	NO	YES	YES	NO	YES	NO	YES	YES
R-H					YES	NO	NO	YES	NO	NO	YES	YES	YES	NO	YES
R-P						YES	YES	YES	NO	NO	YES	NO	YES	NO	NO
W-Sh							NO	YES	NO	NO	YES	NO	YES	NO	NO
W-Sc								YES	NO	NO	YES	NO	YES	NO	NO
W-H									YES	YES	NO	YES	NO	YES	YES
W-P										NO	YES	NO	YES	NO	NO
Sh-Sc											YES	NO	YES	NO	NO
Sh-H												YES	NO	YES	YES
Sh-P													YES	NO	NO
Sc-H														YES	YES
Sc-P															NO
H-P															

Source: Compiled by the Author. (R-Recreation; W-Work; Sh-Shop; Sc-School; H-Health; R-Personal Business)

(,4799). This value was also significantly different from the correlations of the other trips. (Tables 9 and 10)

Summary: Trip Purposes

The work, shop, and school trips stressed factors that dealt with road conditions, traffic conditions, and time restraints. Those trips have known destination points with the time necessary to complete the trip being important (trip must be completed within a certain time limit.) Recreation and health trips, however stressed factors concerning weather conditions, road conditions, some traffic conditions, the surrounding environmental conditions (scenery). These trips are usually taken during periods of free time and do not have definite destination points, so the factors that deal with the time budget would have a limited role. Since the trips are for personal enjoyment, the more pleasurable aspects of the route are ranked high. Weather is an important factor as the trips do not have to take place if the conditions are not favorable or if the conditions favor another route that is more pleasant (favorable wind direction or trees for shade from high temperatures). The personal business trip factors are similar to both the time limited trips (work and school) and the free time trips (recreation and health), as the factors involve weather conditons, road conditions, some traffic conditions, and time restraints. All of the trips had accident potential (safety) ranked at least seven or higher, indicating a concern for safety in a route.

FACTOR VARIATION BY USER TYPES FOR SPECIFIC TRIP PURPOSES

This section was based upon the factors as ranked by the respondents for specific trip purposes. The section investigates the variability of factor selection among different respondent characteristics for specific trip purposes. (Table B-7 to B-12, Appendix B) Abbreviations are used to simplify the

sentence structure and discussion of the results. (BW-bike/walk only, C-casual, BB-bike buff, and U-utility).

The bike/walk only, casual, and bike buff users had similar route factor selection as the correlations between them were all above .8000 for the recreation trip. The values above .8000 were significantly different from zero. Two correlations, the BW-U correlation (.4013) and the BB-U correlation (.3847), were not significantly different from zero. The BW and BB user types were different from the U user in selecting the factors that effect the selection of a recreation route. (Table 11)

Recreation

The test for significance between user type correlation coefficients supported the above conclusions as all the combinations of the cases involving the utility user were significantly different from the other correlations (the BW-U and BB-U coefficients when compared were not significantly different. (Table 12) The correlation of the C-U comparison (.6117) was also found to differ significantly from the other correlations. The remaining correlations were not significantly different from each other, indicating a similarity in factor selection. It can be concluded that the utility user did have different route factor selection behavior for the recreation trip, while the other user types had similar factor selection behavior.

Work

The correlation coefficients for the work trip were significantly different from zero except for one case, the BW-U correlation (.2786). All of the other user type rankings when compared to each other were not significantly different from each other and had relatively strong correlations ranging from .7147 to .8922. (Tables 11 and 12)

Table 4-11

CORRELATION COEFFICIENTS FOR USER TYPES BY TRIP PURPOSE

Recreation

	Bike Only	Casual	Bike Buff	Utility
Bike Only		.8350*	.8050*	.4013
Casual			.8463*	.6117*
Bike Buff				.3847
Utility				

School

	Bike Only	Casual	Bike Buff	Utility
Bike Only		.4969	.7683*	.5991*
Casual			.6907*	.8099*
Bike Buff				.6827*
Utiligy				

Work

	Bike Only	Casual	Bike Buff	Utility
Bike Only		.8282*	.7147*	.2786*
Casual			.8808*	.8922*
Bike Buff				.8344*
Utility				

Health

	Bike Only	Casual	Bike Buff	Utility
Bike Only		.8132*	.6455*	.8390*
Casual			.8055*	.8287*
Bike Buff				.8003*
Utility				

Shop

	Bike Only	Casual	Bike Buff	Utility
Bike Only		.6569*	.5495*	.2786*
Casual			.8344*	.6538*
Bike Buff				.7110*
Utility				

Personal Business

	Bike Only	Casual	Bike Buff	Utility
Bike Only		.6734*	.3849	.8225*
Casual			.7286*	.6785*
Bike Buff				.6099*
Utility				

Source: Compiled by the Author.

Table 4-12

SIGNIFICANT DIFFERENCE BETWEEN USER TYPE CORRELATION COEFFICIENTS

Recreation

	BW-C	BW-BB	BW-U	C-BB	C-U	BB-U
BW-C		NO	YES	NO	YES	YES
BW-BB			YES	NO	YES	YES
BW-U				YES	YES	NO
C-BB					YES	YES
C-U						YES
BB-U						

School

	BW-C	BW-BB	BW-U	C-BB	C-U	BB-U
BW-C		YES	NO	YES	YES	NO
BW-BB			NO	NO	NO	NO
BW-U				NO	YES	NO
C-BB					NO	NO
C-U						NO
BB-U						

Work

	BW-C	BW-BB	BW-U	C-BB	C-U	BB-U
BW-C		NO	YES	NO	NO	NO
BW-BB			YES	NO	NO	NO
BW-U				YES	YES	YES
C-BB					NO	NO
C-U						NO
BB-U						

Health

	BW-C	BW-BB	BW-U	C-BB	C-U	BB-U
BW-C		NO	NO	NO	NO	NO
BW-BB			YES	NO	NO	NO
BW-U				NO	NO	NO
C-BB					NO	NO
C-U						NO
BB-U						

Shop

	BW-C	BW-BB	BW-U	C-BB	C-U	BB-U
BW-C		NO	YES	NO	NO	NO
BW-BB			YES	YES	NO	NO
BW-U				YES	YES	YES
C-BB					NO	NO
C-U						NO
BW-U						

Personal Business

	BW-C	BW-BB	BW-U	C-BB	C-U	BB-U
BW-C		YES	NO	NO	NO	NO
BW-BB			YES	YES	YES	YES
BW-U				NO	NO	YES
C-BB					NO	NO
C-U						NO
BW-U						

Source: Compiled by the Author. (BW-Bike/Walk Only; C-Casual; BB-Bike Buff; U-Utility)

Shop

For shopping trips, all of the correlation coefficients were significant from zero except for one case, the BW-U correlation (.2786). The BW-BB correlation (.5495) was just barely significant from zero and a moderately strong relationship. The C-BB correlation (.8344) was the strongest correlation, so those two user types had similar factor selection behavior. The correlations were not as strong as the C-BB correlation. (Table 11)

The BW-U comparison was significantly different from the other correlations. (Table 12) The BW-BB correlation was significantly different from the C-BB correlation. In conclusion for the shopping trip, the utility users did have different route factor selection behavior then the other user types, which had similar route factor selection except for the one case noted above.

School

The correlation coefficients indicated that only one case existed where the relationship was not significant from zero (.4969 for the BW-C factor ranking comparison). The other correlations ranged from .5991 for BW-U to .8099 for C-U. All of those correlations indicate similar factor selection behavior. (Table 11)

By looking at Table 12, one can see that the BW-C correlation was only significantly different from the correlations of BW-BB, C-BB, and C-U. It did not vary significantly from the correlations for the BW-U and the BB-U users. The correlation between C-U users indicated a strong relationship. In summary, not one user type stands out as having a completely different route factor selection behavior.

Health

On Table 11 one can see that all of the correlation coefficients were significantly different from zero, which indicates that all of the user

types had similar factor selection. The correlation coefficients ranged from .6455 for BW-BB to .8340 for BW-U, the only two correlations to differ significantly from each other. This suggests that statistically the rank factor agreement for the BW-U comparison was significantly more positive than the association for BW-BB. The remaining correlation coefficients were very similar, suggests that the route factor selection behavior for all user types was alike. (Table 12).

Personal Business

In only one case was the correlation coefficient not significantly different from zero; BW-BB correlation (.3849). The other correlation coefficients ranged from .6099 for BB-U to .8225 for BW-U, with all of the cases having similar route factor selection. (Table 11)

The BW-BB correlation was significantly different from the rest of the correlations. This suggests that statistically the rank factor agreement for the BW-BB comparison was significantly less than the associations for the other combinations. One other significant difference existed between the BW-U (.6099) and the BB-U (.8225) correlations. The remaining correlations were not significantly different from each other, no dissimilar route factor selection existed in the user types. (Table 12)

Summary: User Types By Specific Trip Purposes

The route factor selection behavior for a recreation trip was similar among comparison of the bike/walk only, casual, and bike buff user groups. The utility user however, had a different route factor selection behavior than the other user types. For the work trip the bike/walk only, casual, and bike buff users had similar factor selection behavior. The utility user had similar factor selection with the casual and bike buff users, but when compared to the bike/walk only rankings the route selection behavior differed significantly.

The bike/walk only users had similar factor selection with the casual and bike buff users for the shopping trip, while the bike/walk only and utility users had significantly different factor selections. The utility, casual, and bike buff users had similar factor rankings for the shopping trip. For school trips, only the bike/walk only and the casual users had different route factor selection. All of the user types had similar factor selection for health trips. In the personal business trip, the bike/walk only and the bike buff users were the only ones that had significantly different factor selection. (Differences as to the degree of similarity exist for all trips.)

FACTOR VARIATION BY SOCIO-ECONOMIC CHARACTERISTICS FOR SPECIFIC TRIP PURPOSES

Having examined factor variation by user types for specific trip purposes, the factor variation for trips of specific purposes by age, sex, education, and income groups will be investigated. Tables B-13 to B-26 (Appendix B) depict the rankings of the factors by each of the groups for specific trip purposes.

Factor Variation By Age Groups For Specific Trip Purposes

Recreation Trips

The correlation coefficients between the different age groups indicated that similarity did exist in the rankings of factors of route selection among all groups. The correlation coefficients ranged from .6579 for ages under 20 - ages 30 and older to .8798 for ages 20 - 29 ages 30 and older. Table 14 shows that the .6579 correlation was significantly different from the other two correlations. The other two correlations were not significantly different from each other. In conclusion for the recreation trip, similarity did exist among all of the age groups' factor rankings, with only the degree of similarity between groups being different.

Table 4-13

CORRELATION COEFFICIENTS FOR AGE BY TRIP PURPOSES

Recreation

	Under 20	20-29	30
Under 20		.8509*	.6579*
20 - 29			.8798*
30			

Work

	Under 20	20-29	30
Under 20		.6816*	.6429*
20 - 29			.8171*
30			

Shop

	Under 20	20-29	30
Under 20		.8171*	.6135*
20 -29			.8512*
30			

School

	Under 20	20-29	30
Under 20		.7472*	.6641*
20 - 29			.7085*
30			

Health

	Under 20	20-29	30
Under 20		.7317*	.3553
20 - 29			.7575*
30			

Personal Business

	Under 20	20-29	30
Under 20		.7278*	.6171*
20 - 29			.7523*
30			

Table 4-14

SIGNIFICANT DIFFERENCE BETWEEN AGE CORRELATION COEFFICIENTS

Recreation

	AA/BB	AA/CC	BB/CC
AA/BB		YES	NO
AA/CC			YES
BB/CC			

Work

	AA/BB	AA/CC	BB/CC
AA/BB		NO	NO
AA/CC			NO
BB/CC			

Shop

	AA/BB	AA/CC	BB/CC
AA/BB		YES	NO
AA/CC			YES
BB/CC			

School

	AA/BB	AA/CC	BB/CC
AA/BB		NO	NO
AA/CC			NO
BB/CC			

Health

	AA/BB	AA/CC	BB/CC
AA/BB		YES	NO
AA/CC			YES
BB/CC			

Personal Business

	AA/BB	AA/CC	BB/CC
AA/BB		NO	NO
AA/CC			NO
BB/CC			

Source: Compiled by the Author. (AA-Under 20; BB- 20-29; CC- 30)

Work Trips

The correlation coefficients for the age groups for the work trip were all significantly different from zero. (Table 13) The correlations ranged from .6429 to .8171. The .8171 was stronger than the other correlations, but it was not significantly different from the other correlation values, (Table 14) In conclusion, no significant differences in factor selection between age groups for work trips was found.

Shopping Trips

The correlation coefficients for the shopping trip by age groups ranged from .6135 (under 20-30 and older) to .8512 (20 to 29-30 and older). All of the values indicated that similarity did exist in the rankings of the factors. The .6135 correlation was significantly different than the other two correlations. (Tables 13 and 14)

School Trips

Age groups were very similar in their route factor selection as their correlation coefficients ranged from .6641 to .7472. The correlations were not significantly different from each other. (Tables 13 and 14)

Health Trips

The under 20 and 30 and older correlation coefficient (.3553) was not significantly different from zero, implying that the under 20 and 30 and older age groups had different route selection behavior. The other two correlation coefficients, .7317 and .7575, indicated that the under 20 and 20 to 29 age groups and the 20 - 29 and 30 and older age groups had similar route factor ranking behavior. The lowest correlation coefficient (.3553) was also found to differ significantly from the other correlation coefficients. (Tables 13 and 14)

Personal Business

All of the correlation coefficients were significantly different from zero and ranged from .6171 to .7523. Age did not make a difference in the selection of factors for a personal business trip as no significant variation was found between the different correlation coefficients. (Tables 13 and 14)

Summary: Age By Trip Purpose

For recreation, shopping, work, school, and personal business trips, all of the age categories had similar factor selection. In the health trip, the only case in which there was significant differences was the under 20 and 30 and older age categories.

Factor Variation By Sex For Specific Trip Purposes

For all of the trip purposes, no significant differences existed between the factors ranked by males and females. The correlation coefficients ranged from .7701 for a personal business trip to .9556 for a recreation trip. (Table 15)

Factor Variation By Education For Specific Trip Purposes

Recreation

Once again abbreviations are used to simplify the sentence structure and discussion of the results. (SC-some college; C-college; and SG-some graduate/graduate) All of the correlation coefficients among the education groups are significantly different from zero, with a range from ,7642 (SC-C) to .8596 (SC-SG). (Table 16) The education groups were very similar in their route factor selection as reflected by the high correlation coefficients. The correlation coefficients were not significantly different from each other. (Table 17)

Table 4-15

CORRELATION COEFFICIENTS AND SIGNIFICANCE FOR SEX BY TRIP PURPOSES

Trip Purpose	Correlation Coefficient	Significant From 0	Significant From Coefficients *
Recreation	.9556	YES	NO
Work	.9355	YES	NO
Shop	.8736	YES	NO
School	.8803	YES	NO
Health	.8189	YES	NO
Personal Business	.7701	YES	NO

Source: Compilation by Author. (* - No For All Cases)

Table 4-16

CORRELATION COEFFICIENTS FOR EDUCATION BY TRIP PURPOSES

Recreation

	Some Coll.	College	Some Grad/Grad.
Some Coll.		.7642*	.8596*
College			.7846*
Some Grad/Grad			

School

	Some Coll.	College	Some Grad/Grad.
Some Coll.		.7874*	.9123*
College			.8545*
Some Grad/Grad			

Work

	Some Coll.	College	Some Grad/Grad.
Some Coll.		.8658*	.8927*
College			.8238*
Some Grad/Grad			

Health

	Some Coll.	College	Some Grad/Grad.
Some Coll.		.7745*	.7802*
College			.8256*
Some Grad/Grad			

Shop

	Some Coll.	College	Some Grad/Grad.
Some Coll.		.6491*	.7946*
College			.7554*
Some Grad/Grad			

Personal Business

	Some Coll.	College	Some Grad/Grad.
Some Coll.		.8132*	.8153*
College			.7797
Some Grad/Grad			

Source: Compiled by Author.

Table 4-17

SIGNIFICANT DIFFERENCE BETWEEN EDUCATION CORRELATION COEFFICIENTS

Recreation

	SC-C	SC-SG	C-SG
SC-C	____	NO	NO
SC-SG	_____	_____	NO
C-SG	_____	_____	_____

School

	SC-C	SC-SG	C-SG
SC-C	____	NO	NO
SC-SG	_____	_____	NO
C-SG	_____	_____	_____

Work

	SC-C	SC-SG	C-SG
SC-C	____	NO	NO
SC-SG	_____	_____	NO
C-SG	_____	_____	_____

Health

	SC-C	SC-SG	C-SG
SC-C	____	NO	NO
SC-SG	_____	_____	NO
C-SG	_____	_____	_____

Shop

	SC-C	SC-SG	C-SG
SC-C	____	NO	NO
SC-SG	_____	_____	NO
C-SG	_____	_____	_____

Personal Business

	SC-C	SC-SG	C-SG
SC-C	____	NO	NO
SC-SG	_____	_____	NO
C-SG	_____	_____	_____

Source: All calculations by Author. (SC-Some College; C-College; SG-Some Graduate/Graduate)

Work

The correlations ranged from .8238 (C-SG) to .8927 (SC-SG). None of the correlation coefficients differed significantly from the others. (Table 17) In conclusion, no significant differences exist in the route factor selection for a work trip by education categories.

Shop

The correlation coefficients for the various education groups ranged from .6491 (SC-C) to .7946 (SC-SG). The groups did have similarity in their route factor selection. (Table 16) None of the correlations were significantly different from the others. (Table 17)

School

SC-C had the lowest correlation (.7874) with SC-SG having the highest (.9123). (Table 16) There were no significant differences between the different correlations. (Table 17) The education groups had similar factor selection for the school trip.

Health

The C-SG correlation (.8256) was the highest correlation between factor rankings for health trips by education groups, with SC-C having the lowest correlation (.7745). All of the correlations indicated similar factor selection. (Table 16) All of the groups had similar factor selection for a health trip as none of the correlations were significantly different from the other. (Table 17)

Personal Business

All of the correlations were significantly different from zero, which indicated that similarity existed between the education group combinations.

The correlations ranged from .7797 for the C-SG correlation to .8153 for the SC-SG correlation. None of the correlations were significantly different from the others, which indicates similarity of factor selection among all education categories for the personal business trip. (Tables 16 and 17),

Summary: Education By Trip Purposes

All of the education categories had similar behavior for all of the trip purposes.

Factor Variation By Income For Specific Trip Purposes

Recreation

The correlation coefficients ranged from .7394 (o to 7,000 - 15 to 25,000) to .9559 (7 to 12,000 - 25,000 and greater). While .7394 was a strong relationship, the .9559 was almost a perfect relationship. (Table 18) Only two cases occurred where the correlation coefficients were significantly different from each other. These were 0 to 7,000 - 15 to 25,000 compared with both the 7 to 12,000 - 25,000 and greater correlation, and with the 15 to 25,000 - 25,000 and greater correlation. The remaining correlations comparisons was not significantly different. (Table 19)

Work

The correlation coefficient ranged from .7131 (7 to 12,000 - 15 to 25,000) to .8715 (0 to 7,000 - 12 to 15,000). The correlation coefficients did not differ significantly from each other. (Tables 18 and 19)

Shop

The range of the correlation coefficients for the shopping trip factor variation by income was from .5642 (7 to 12,000-25,000 and greater) to .8395 (12 to 15,000 - 25,000 and greater). When the factor rankings of each

Table 4-18

CORRELATION COEFFICIENTS BY INCOME GROUPS FOR SPECIFIC TRIP PURPOSES

Recreation

	0-7	7-12	12-15	15-25	25→
0-7	—	.7936*	.8308*	.7394*	.8256*
7-12			.9174*	.8927*	.9559*
12-15				.8323*	.9293*
15-25					.9056*
25→					

School

	0-7	7-12	12-15	15-25	25→
0-7	—	.6744*	.7317*	.7998*	.7554*
7-12			.7270*	.6280*	.6579*
12-15				.8478*	.8222*
15-25					.9087*
25→					

Work

	0-7	7-12	12-15	15-25	25→
0-7	—	.7268*	.8715*	.7874*	.8199*
7-12			.8395*	.7131*	.8075*
12-15				.8029*	.8617*
15-25					.7307*

Health

	0-7	7-12	12-15	15-25	25→
0-7	—	.6313*	.6233*	.8571*	.8055*
7-12			.7312*	.8658*	.8308*
12-15				.6339*	.5800*
15-25					

Shop

	0-7	7-12	12-15	15-25	25→
0-7	—	.6785*	.5996*	.6068*	.5939*
7-12			.6011*	.7023*	.5642*
12-15				.6914*	.8396*
15-25					.7792*
25→					

Personal Business

	0-7	7-12	12-15	15-25	25→
0-7	—	.6672*	.3829*	.6945*	.4721
7-12			.5702*	.7363*	.5970*
12-15				.7090*	.6909*
15-25					.7224*
25→					

Source: Compiled by the Author. (Income labels are given in thousands of dollars)

Table 4-19

SIGNIFICANT DIFFERENCE BETWEEN INCOME CORRELATION COEFFICIENTS BY TRIP PURPOSE

Recreation Trip	0-7 / 7-12	0-7 / 12-15	0-7 / 15-25	0-7 / 25→	7-12 / 12-15	7-12 / 15-25	7-12 / 25→	12-15 / 15-25	12-15 / 25→	15-25 / 25→
0-7 / 7-12	____	NO	NO	NO	NO	NO	NO	NO	NO	NO
0-7 / 12-15		____	NO	NO	NO	NO	NO	NO	NO	NO
0-7 / 15-25			____	NO	NO	NO	YES	NO	YES	NO
0-7 / 25→				____	NO	NO	NO	NO	NO	NO
7-12/12-15					____	NO	NO	NO	NO	NO
7-12/15-25						____	NO	NO	NO	NO
7-12/25→							____	NO	NO	NO
12-15/15-25								____	NO	NO
12-15/25→									____	NO
15-25/25→										____
Work Trip										
0-7 / 7-12	____	NO	NO	NO	NO	NO	NO	NO	NO	NO
0-7 / 12-15		____	NO	NO	NO	NO	NO	NO	NO	NO
0-7 / 15-25			____	NO	NO	NO	NO	NO	NO	NO
0-7 / 25→				____	NO	NO	NO	NO	NO	NO
7-12/12-15					____	NO	NO	NO	NO	NO
7-12/15-25						____	NO	NO	NO	NO
7-12/25→							____	NO	NO	NO
12-15/15-25								____	NO	NO
12-15/25→									____	NO
15-25/25→										____

Continued on following page

Table 4-19 Significant Difference Between Income Correlation Coefficients By Trip Purpose (Continued)

Shopping Trip	0-7 / 7-12	0-7 / 12-15	0-7 / 15-25	0-7 / 25→	7-12 / 12-15	7-12 / 15-25	7-12 / 25→	12-15 / 15-25	12-15 / 25→	15-25 / 25→
0-7 / 7-12		NO	NO	NO	NO	NO	NO	NO	NO	NO
0-7 / 12-15			NO	NO	NO	NO	NO	NO	NO	NO
0-7 / 15-25				NO	NO	NO	NO	NO	NO	NO
0-7 / 25→					NO	NO	NO	NO	NO	NO
7-12/12-15						NO	NO	NO	NO	NO
7-12/15-25							NO	NO	NO	NO
7-12/25→								NO	YES	YES
12-15/15-25									NO	NO
12-15/25→										NO
15-25/25→										

School Trip	0-7 / 7-12	0-7 / 12-15	0-7 / 15-25	0-7 / 25→	7-12 / 12-15	7-12 / 15-25	7-12 / 25→	12-15 / 15-25	12-15 / 25→	15-25 / 25→
0-7 / 7-12		NO	NO	NO	NO	NO	NO	NO	NO	YES
0-7 / 12-15			NO	NO	NO	NO	NO	NO	NO	NO
0-7 / 15-25				NO	NO	NO	NO	NO	NO	NO
0-7 / 25→					NO	NO	NO	NO	NO	NO
7-12/12-15						NO	NO	NO	NO	NO
7-12/15-25							NO	YES	YES	YES
7-12/25→								YES	NO	YES
12-15/15-25									NO	NO
12-15/25→										NO
15-25/25→										

Continued on following page

Table 4-19 Significant Difference Between Income Correlation Coefficients By Trip Purpose (Continued)

Health Trip	0-7 / 7-12	0-7 / 12-15	0-7 / 15-25	0-7 / 25→	7-12 / 12-15	7-12 / 15-25	7-12 / 25→	12-15 / 15-25	12-15 / 25→	15-25 / 25→
0-7 / 7-12	____	NO	YES	NO	NO	YES	NO	NO	NO	YES
0-7 / 12-15		____	YES	YES	NO	YES	NO	NO	NO	YES
0-7 / 15-25			____	NO	NO	NO	NO	YES	YES	NO
0-7 / 25→				____	NO	NO	NO	NO	YES	NO
7-12/12-15					____	NO	NO	NO	NO	YES
7-12/15-25						____	NO	YES	YES	NO
7-12/25→							____	YES	YES	NO
12-15/15-25								____	NO	YES
12-15/25→									____	YES
15-25/25→										____

Personal Business Trip	0-7 / 7-12	0-7 / 12-15	0-7 / 15-25	0-7 / 25→	7-12 / 12-15	7-12 / 15-25	7-12 / 25→	12-15 / 15-25	12-15 / 25→	15-25 / 25→
0-7 / 7-12	____	YES	NO	YES	NO	NO	NO	NO	NO	NO
0-7 / 12-15		____	YES	NO	YES	YES	YES	YES	YES	YES
0-7 / 15-25			____	YES	NO	NO	NO	NO	NO	NO
0-7 / 25→				____	NO	YES	NO	YES	YES	YES
7-12/12-15					____	NO	NO	NO	NO	NO
7-12/15-25						____	NO	NO	NO	NO
7-12/25→							____	NO	NO	NO
12-15/15-25								____	NO	NO
12-15/25→									____	NO
15-25/25→										____

Source: Calculations by the Author. (Income is given in thousands of dollars)

income category were compared, they did have similar route factor selection. In conclusion, in all cases of income categories similarity exists, but the degree of similarity varies significantly. (Tables 18 and 19)

School

The correlation coefficients for the income group rankings ranged from .6280 to .9087 for school trips. The correlation coefficients were all significantly different from zero meaning that a positive relationship (similarity) did exist between the different rankings. (Table 18) Six cases existed where two of the income correlations were significantly different from each other, indicating that some of the correlations were significantly more positive than the other combinations. In conclusion, all of the income groups have factor similarity, although some significant differences did exist in the degree of similarity. (Table 19)

Health

When the rankings of the factors by the different income categories were compared, the resulting correlation coefficients ranged from .5890 (12 to 15,000 - 25,000 and greater) to .9190 (15 to 25,000 and greater). (Table 18) More variability existed between the income groups in this type of trip than in the others as there were seventeen cases in which two correlation coefficients were significantly different from each other. (Table 19)

Personal Business

Two correlation coefficients between ranked factors by income categories were not significantly different from zero (0 to 7,000 - 12 to 15,000) (.3829) and 0 to 7,000 - 25,000 and greater (.4721). The remaining correlations ranged from .5702 to .7363. (Table 18) The two lowest correlations noted above were significantly different from all but three of the other correlations.

(Table 19) Major differences exist with the 0 to 7,000 income category between the 12 to 15,000 and the 25,000 and greater income categories in their factor selection for a personal business trip. The remaining correlations were all similar in their factor rankings.

Conclusions: Income By Trip Purpose

Income categories had similarity in factor selection for all trip purposes except in the personal business trip where the 0 to 7,000 category had a route factor selection behavior that differed from the behavior of the 12 to 15,000 and 25,000 and greater income categories.

ACTUAL VERSUS MINIMUM DISTANCE FOR BIKE ROUTES

The previous sections stressed the factors that affect route selection. We will not turn to a closer examination of the role of distance in the choice of a bicycle route. Many of the models of travel behavior of the other modes stress the importance of minimum time (distance) in route selection. The purpose of this section is to investigate the importance of minimum time (distance) in bicycle route selection behavior. It is assumed that the differences between actual paths and minimum distance paths increases as the role of route selection on factors other than distance become more important.

Survey

The data used in the investigation of route distances was obtained from the blank map section of the survey. (Appendix A) The respondents were asked to plot the routes taken most frequently for specific trip purposes in the month of March. The results of the plotting procedure allowed the investigation of the role of distance in work, shopping, school, and personal business routes. Those trip routes were among the most frequently mapped and are ones in which

time plays a major role. They also have specific destination points. The recreation trip routes were the most frequently plotted routes, but the role of time is probably less than for other types of trips so distance will not be of major importance. This suggested the deletion of the recreation trip from further investigation.

Trip Length Determination

The actual lengths of the routes taken for the trips were measured from maps using a scale, that was divided into tenths of miles. Each of the routes were measured three times, with the final distance recorded for that trip being the average of those three values. If the respondent had plotted several routes for a specific trip purpose, all were measured three times and an average value for the trip purpose obtained by calculating the average for all the routes. The minimum trip lengths were determined in a similar manner. All of the routes were measured on the transportation grid of the city, not "as the crow flies".

Statistics Used

The distances obtained from the surveys were tested to see if the actual distances traveled differed significantly from minimum distance paths. The first step of this test was the calculation of the mean actual distance and the mean minimum distance for each trip purpose. This was done by totalling all of the trip lengths for actual and minimum paths for each of the trip types under study. The total was then divided by the number of cases to determine the mean actual and minimum distances.

The second step utilized the difference of means test which determined if there was significant differences in trip length means for actual versus minimum distance paths. The test involved the following equations:

The estimate of the standard error of the difference between sample means

had to be calculated as follows:

$$\hat{\sigma}_{\bar{x}_1-\bar{x}_2} = \sqrt{\frac{N_1 s_1^2 + N_2 S_2^2}{N_1 + N_2 - 2}} \quad \sqrt{\frac{N_1 + N_2}{N_1 N_2}} \qquad 10$$

Where:

$\hat{\sigma}_{\bar{x}_1-\bar{x}_2}$ = the unbiased estimate of the standard error of the differences between sample means

$s1^2$ = sample variance for data from sample 1 (actual trip lengths)

$s2^2$ = sample variance for data from sample 2 (minimum trip lengths)

N_1 = number of cases in sample 1

N_2 = number of cases in sample 2

$\bar{x}_1$ = mean value for sample 1

$\bar{x}_2$ = mean value for sample 2

The difference of means test is as follows:

$$t = \frac{(\bar{x}_1 - \bar{x}_2) - 0}{\hat{\sigma}_{\bar{x}_1 - \bar{x}_2}} \qquad 11$$

$\bar{x}_1$ = mean value for sample 1

$\bar{X}_2$ = mean value for sample 2

$\hat{\sigma}_{\bar{x}_1-\bar{x}_2}$ = unbiased estimate of the difference between sample means

Results

For the population under study the work trip was the longest trip length as it had a mean value of 1.768 miles for actual distance and 1.69 miles for minimum distance paths. It was followed by the personal business trip (1.41 actual versus 1.39 minimum), school (1.30 actual versus 1.26 minimum), and shopping (1.07 actual versus 1.04). The mean values of actual and minimum distances for each of the trips do not appear to vary much from each other.

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[10] Blalock, op. cit., pp. 220-228.

[11] Ibid.

(Table 20)

Each of the trips had very low t values when the difference between actual and minimum distance means were tested. (Table 20) None of those values were significant enough to reject the hypothesis that the means were alike which required a t value greater than 2.372 to reject at the .01 significance level. So it can be concluded that bicycles generally take minimum distance paths for work, school, shoppping, and personal business trips.

Summary: Actual Versus Minimum Distance

With bicyclists taking minimum distance paths for the above trips, it can be concluded that time and distance are important factors in the selection of routes for those trip types. It also means that bicyclists would tend to take the shortest and most direct routes possible to the desired destination points. In the recreation and health trips, time and distance would be expected to play a limited role in the selection of a route. This was supported by the factor rankings on Table B-6 (Appendix B). For example, in the work trip-distance, time necessary to complete trip, and directness were ranked in the top five factors of route selection, while for a recreation trip none of those factors were ranked in the top nine factors (time necessary to complete trip was tenth).

Table 4-20

ACTUAL ROUTE DISTANCES VERSUS MINIMUM ROUTE DISTANCES

Trip Type	Actual Mean	Minimum Mean	Number of respondents	t Value
Work	1.768 miles	1.69 miles	31	.2592
Shop	1.07 miles	1.04 miles	50	.2273
School	1.30 miles	1.26 miles	88	.2878
Personal Business	1.41 miles	1.39 miles	42	.1037

Source: Compiled by Author.

Chapter V

CONCLUSIONS AND IMPLICATIONS

The role of the bicycle is presently increasing in importance as a viable mode of urban transportation. Most bicycle studies today have focused primarily on user characteristics and not upon the route selection process and its variation among different bicyclists.

The purpose of this thesis was to study the route factor selection variability of bicyclists. This was done by answering the following five questions: (1) What factors are important in the selection of a route by a bicyclist? (2) How do these factors vary with the different user types? (3) How do the factors vary with different socio-economic status? (4) How do the factors vary with trip purpose? and (5) How do the actual bike route choices vary from minimum distance paths? Hopefully the answers to these questions will provide a better understanding of bicycle route selection behavior.

Conclusions

The study did identify the general factors of route selection for bicyclists in Manhattan, Kansas and determined their relative importance. The most influential factors of route selection for all trip purposes were in order of decreasing influence; weather, condition of road surface, accident potential (safety), number of heavy vehicles, wind velocity and direction, number of vehicles, attractive scenery along route, temperature, and speed of vehicles. The weather (climate) related factors are an important consideration, but would be difficult to incorporate in the planning process. The other factors would be fairly easy to incorporate into a bikeway system in order to satisfy the desires of bicyclists. While the routes of bicyclists are largely determined by attractive scenery, safety, weather, traffic, and road conditions along the

route, the factors that have the least impact on the selection of a route include; number of pedestrians, number of stop signs, amount of cross traffic, noise and air quality.

In answer to question number two, the factors of route selection do not vary significantly among the user types. The bike/walk only and casual users had the most similar factor rankings, with bike/walk only and bike buff users having the weakest similarity for the factors rankings of all trips. For specific trip purposes, some variation in factor selection was present among the user types. In a recreation trip the utility user had different factor rankings than the other user types. Utility users stressed road conditions in their factor rankings, while the other users stressed weather conditions and scenery. For the work trip the only differences in factor rankings occured between th bike/walk only and utility users, as was the case with the shopping trip. All of the user types had similar factor selection for school trip and health trips. Bike/walk only and bike buff users had variation in their factor rankings for personal business trips.

Analysis of factor variation with different socio-economic status for the general factor rankings disclosed that sex, education, and income groups were all similar. For age, the 30 and older age group had different factor selection as they stressed road conditions and traffic conditions, while the other age groups stressed weather and traffic conditions. In looking at the factor variation with specific trip purposes by the different socio-economic categories, variation was noted between the under 20 and 30 and older age groups for the health trips. Significant variability existed in the personal business trip for the 9 - 7,000, 12 - 15,000, and 25,000 and greater income groups. All of the other socio-economic groups had similarity in their factor rankings.

The factors did vary with trip purpose as the factor rankings for recreation and health trips were significantly different from the factor rankings for work, shop, and school trips. The personal business trip had factor

that were similar with all of the other trip factor rankings. The recreation and health trips had the following factors ranked as being most important; weather, temperature, attractive scenery, condition of road surface, number of vehicles, and steepness of grades. The remaining trip types possessed the following major factors; weather, time necessary to complete trip, number of vehicles, distances, and accident potential (safety).

The data indicated that the bicyclist surveyed took minimum distance paths for shopping, work, school, and personal business trips. This meant that time (distance) is an important factor in the selection of a route for those trip purposes. In the remaining trip types factors other than time are important in the selection of a route.

Implications

In planning for specific trip purposes, the bikeway planner needs to be aware of the trip type (purpose) that dominates the area of proposed bikeway development. This is because of the variation of route selection factors with different trip purposes. Making a route for all trip purposes would have certain ramifications in the amount of usage by the different user types. A recreational user would not likely use a route designed for work trips, if the route was designed to meet the route selection factors of the work trip. In one route for all trip purposes, does not isolate all of the important factors desired for the different trip purposes handled by that route. Hopefully the general factors of route selection for all trips would suffice the desires of the users, but single purpose routes would only be convenient for that designed purpose as serious variations in the desired factors for the route may exist for different trips. Routes could be designed jointly for recreation, health, and personal business, or for work, shop, school, and/or personal business, depending upon the needs, desires, and structure (physical and social) of the area of the community planning the bikeway.

The routes that are planned must meet in addition to the desired factors, the characteristic of minimum distance to the major trip generating points in the area, as bicyclists tend to choose minimum distance paths for purposeful trips. This is another reason for the development of separate routes for the recreation and work trips.

Any new studies on bicyclist behavior should investigate the factors of route selection in more detail. Continued study of this behavior could possibly lead to even better planning and placement of bikeway facilities. As this behavior becomes better understood and perhaps modeled in the future, planners should turn to planning for human (the bicyclists) needs and desires, not concentrating on the physical (engineering) criteria that they have been stressing.

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APPENDICES

APPENDIX A

Factors Of Bicycle Route Selection Survey

The purpose of this survey is to provide a base of information for understanding what factors influence the routes taken by bicyclists, The survey is part of the research I am doing for my Masters Thesis at K.S.U. Your responses will be kept confidential.

(1) Which of the four types of bicycle users listed below best describes your status as a bicyclist? (If more than one of the user types fits your status, rank them in order of the best fit to worst fit such that 1 equals best and 4 equals worst.)

__A. Bicycling and walking are the only transportation opportunities available.

__B. A casual user - bike used primarily for recreation.

__C. A real buff - uses the bike as often as possible for most trips.

__D. Utility user - use the bike primarily for commuting and errands.

(2) How many trips by bicycle during a typical seven day week in March do you take for the following purposes? (If you do not take a particular trip, indicate so with an "X".)

__recreational __ work __ school __health (exercise) __ shopping

__personal business (socializing) __other.

(3) To what extend to the following factors influence your selection of a particular bicycle route? (Indicate by checking the appropriate position on the scale. If a factor that you feel is important does not appear on the list, please add it to thelist and scale it according to the instructions.)

	HARDLY ANY EFFECT			SOME EFFECT			TO A GREAT EFFECT
a. Weather	____	____	____	____	____	____	____
b. Temperature	____	____	____	____	____	____	____
c. Wind velocity and direction	____	____	____	____	____	____	____
d. Darkness/light	____	____	____	____	____	____	____
e. Steepness of grades	____	____	____	____	____	____	____
f. Traffic (speed of vehicles)	____	____	____	____	____	____	____
g. Traffic (number of vehicles)	____	____	____	____	____	____	____
h. Traffic (number of heavy vehicles)	____	____	____	____	____	____	____
i. Number of pedestrians	____	____	____	____	____	____	____
j. Number of stop signs	____	____	____	____	____	____	____
k. Amount of cross traffic	____	____	____	____	____	____	____
l. Distance	____	____	____	____	____	____	____
m. Time necessary to complete trip	____	____	____	____	____	____	____

n. Condition of road _____
o. Attractive scenery along route _____
p. Accident potential (safety) _____
q. Amount of noise and air quality _____
r. Directness _____
s. _____ _____
t. _____ _____
u. _____ _____
v. _____ _____

(4) Rank the five factors that would most affect your selection of a route for each of the following trip purposes. Please use the factors listed in Question 3, unless there are other factors that exist that would affect the selection of the route for the trip in question. If you have never completed a bicycle trip of a particular type, please circle that type, but feel free to rnak the factors that you feel would apply.

	Recreation	Work	Shopping
1.			
2.			
3.			
4.			
5.			

	School	Health	Personal Business (Socializing)
1.			
2.			
3.			
4.			
5.			

(5) What is your age? _____ years

(6) What is your sex? _____male _____female

(7) Please indicate your level of education completed. _____grade school _____high school _____some college _____college _____some graduate school _____graduate school

(8) Please indicate the level of your family income. _____less than $7000 _____$7,000-$12,000 _____$12,000 - $15,000 _____$15,000 - $25,000 _____over $25,000

(9) What type of bicycle do you use?
_____single speed _____three speed _____five speed _____ten speed _____other

BLANK MAP SECTION

On the map that accompanies this survey, it is desired that you plot the bike routes that you commonly take during March. Please specify the trip purpose for each route.

ILLEGIBLE DOCUMENT

THE FOLLOWING DOCUMENT(S) IS OF POOR LEGIBILITY IN THE ORIGINAL

THIS IS THE BEST COPY AVAILABLE

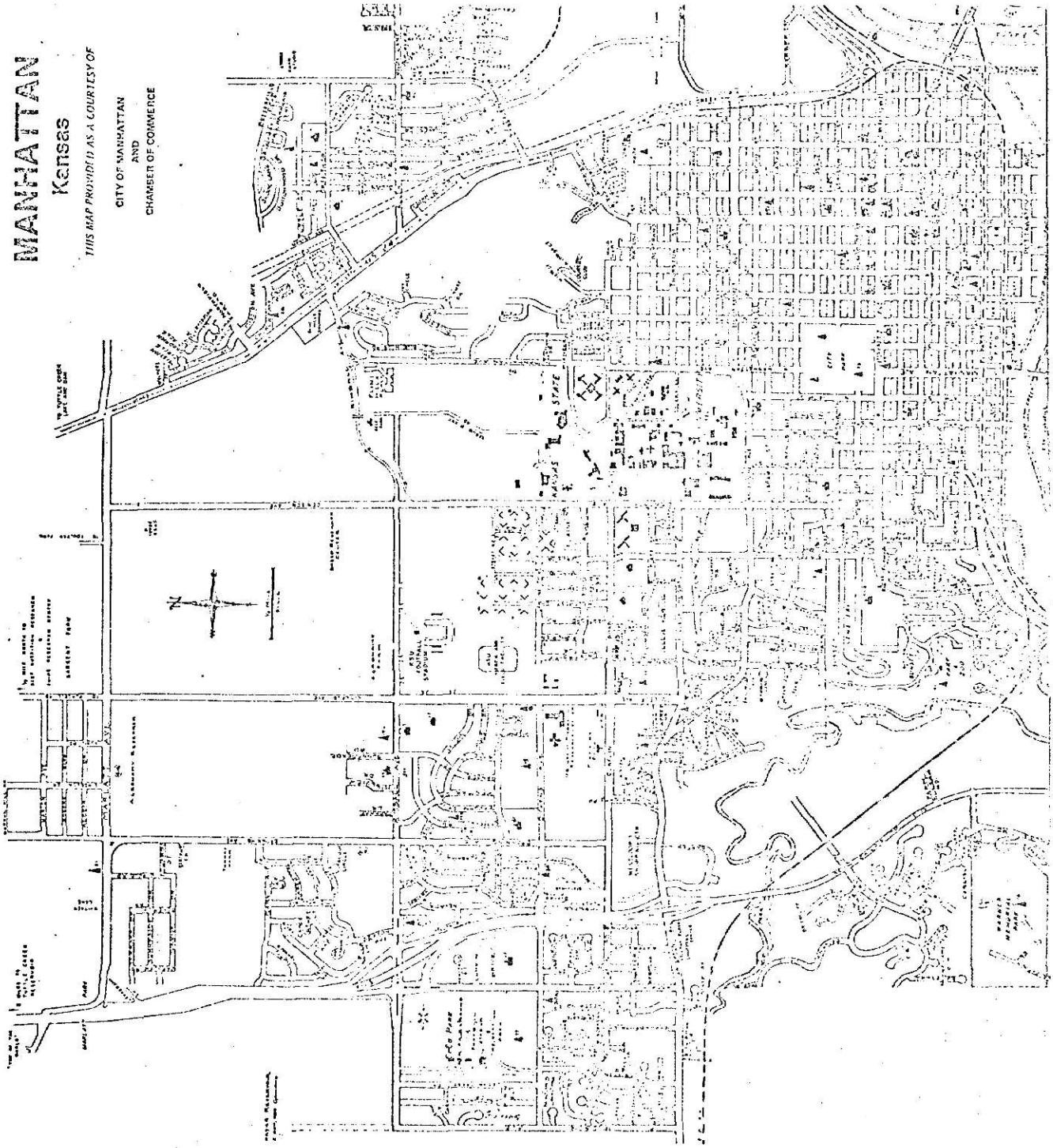
MANHATTAN
Kansas
THIS MAP PROVIDED AS A COURTESY OF
CITY OF MANHATTAN
AND
CHAMBER OF COMMERCE

Table B-1

RANKINGS OF FACTOR MEANS BY USER TYPES

Factors	Bike Only	Casual	Bike Buff	Utility
Weather	2	1	10	1
Temperature	8	2	14	14
Wind Velocity and Direction	4.5	3	5.5	13
Darkness/Light	16	10	1.5	5
Steepness of Grades	15	12.5	16	9
Traffic (Speed of vehicles)	9	9	5.5	7.5
Traffic (number of vehicles)	6.5	6.5	3.5	7.5
Traffic (number of heavy vehicles)	4.5	4.5	3.5	6
Number of pedestrians	18	18	18	18
Number of stop signs	17	17	17	17
Amount of cross traffic	12	16	13	15
Distance	13	12.5	15	12
Time necessary to complete trip	14	11	11.5	11
Condition of road surface	3	4.5	7	2
Attractive scenery along route	1	6.5	9	10
Accident potential (safety)	6.5	8	1.5	3
Noise potential (safety)	11	14	8	16
Directness	10	15	11.5	4

Source: Compiled by Author from the Cross-Tabs Computer Run.

Table B-2

RANKINGS OF FACTOR MEANS BY AGE GROUPS

Factors	Under 20	20-29	30 and over
Weather	1	1	10
Temperature	3	10	14
Wind Velocity and Direction	2.	4.5	15
Darkness/Light	10.5	9	7
Steepness of Grades	16	13	11
Traffic (speed of vehicles)	6	8	12.5
Traffic (number of vehicles)	8	4.5	3.5
Traffic (Number of heavy vehicles)	4	6	3.5
Number of Pedestrians	18	10	18
Number of Stop Signs	17	17	17
Amount of Cross Traffic	15	16	16
Distance	12.5	14	8
Time Necessary to Complete Trip	10.5	12	12.5
Condition of Road Surface	6	2	1
Attractive Scenery Along Route	6	7	3.5
Accident Potential (safety)	9	3	3.5
Noise and Air Quality	14	15	9
Directness	12.5	11	6

Source: Compiled by Author.

Table B-3

RANKINGS OF FACTOR MEANS BY SEX

Factors	Male	Female
Weather	1	1
Temperature	7.5	9
Wind Velocity and Direction	6	2
Darkness/Light	9	10
Steepness of Grades	14	11
Traffic (speed of vehicles)	11.5	5
Traffic (number of vehicles)	5	5
Traffic (number of heavy vehicles)	4	5
Number of Pedestrians	17	18
Number of Stop Signs	18	17
Amount of Cross Traffic	16	15.5
Distance	13	13.5
Time Necessary to Complete Trip	10	15.5
Condition of Road Surface	2	8
Attractive Scenery Along Route	7.5	3
Accident Potential (safety)	3	7
Noise and Air Quality	15	13.5
Directness	11.5	12

Source: Compiled by Author.

Table B-4

RANKINGS OF FACTOR MEANS BY EDUCATION

Factors	Some College	College	Some Grad/Grad.
Weather	1	3	7
Temperature	5	8.5	15
Wind VElocity and Direction	2	3	12.5
Darkness/Light	10	7	10
Steepness of Grades	14	13	14
Traffic (speed of vehicles)	9	10	8.5
Traffic (number of vehicles)	6	11.5	2
Traffic (number of heavy vehicles)	3	8.5	5
Number of Pedestrians	17	18	18
Number of Stop Signs	18	17	17
Amount of Cross Traffic	16	16	16
Distance	11.5	15	11
Time Necessary to Complete Trip	11.5	11.5	8.5
Condition of Road Surface	4	1	4
Attractive Scenery Along Road	8	3	3
Accident Potential (safety)	7	6	1
Noise and Air Quality	15	14	12.5
Directness	13	5	6

Source: Compiled by Author.

Table B-5

RANKINGS OF FACTOR MEANS BY INCOME GROUPS

Factors	0-7000	7-12000	12-15000	15-25000	25
Weather	1	1	3.5	1	1
Temperature	8	2	12	10	7
Wind Velocity and Direction	5.5	8.5	6	7.5	10
Darkness/Light	12.5	5	.6	5	8
Steepness of Grades	14	11	10	13.5	16
Traffic (speed of vehicles)	7	7	11	9	6
Traffic (number of vehicles)	9.5	4	7	6	4.5
Traffic (number of heavy vehicles)	11	6	2	4	3
Number of Pedestrians	18	18	18	18	17
Number of Stop Signs	17	17	17	17	18
Amount of Cross Traffic	16	16	15	16	14
Distance	9.5	14.5	9	13.5	.5
Time Necessary to Complete Trip	12.5	12.5	8	11	13
Condition of Road Surface	4	3	1	3	4.5
Attractive Scenery Along Route	3	8.5	3.5	7.5	9
Accident Potential (safety)	5.5	10	5	2	2
Noise and Air Quality	15	12.5	13	15	12
Directness	2	14.5	14	12	11

Source: Compiled by Author.

Table B-6

FACTOR RANKINGS BY TRIP PURPOSES

Factors	Recreation	Work	Shop	School	Health	Personal Business
Weather	1	1	1	1	1	1
Temperature	3	10	10.5	7	6	4.5
Wind Velocity and Direction	8	12	12	10	11	13
Darkness/Light	9	11	10.5	12	8	6
Steepness of Grades	6	7	7	8	3	9
Traffic (speed of vehicles)	11	9	8	11	12	12
Traffic (number of vehicles)	4	4	2	4	5	2
Traffic (number of heavy vehicles)	14	13	14	16.5	13	14
Number of Pedestrians	18	17	18	15	16.5	18
Number of Stop Signs	17	15	15.5	13	15	17
Amount of Cross Traffic	15	14	13	16.5	16.5	15
Distance	12	5	4	9	10	10
Time Necessary to Complete Trip	10	2	9	2	9	3
Condition of Road Surface	5	8	6	6	3	4.5
Attractive Scenery Along Route	2	16	15.5	14	3	11
Accident Potential (safety)	7	6	3	5	7	7
Noise and Air Quality	13	18	17	18	14	16
Directness	16	3	15	3	18	8

Source: Compiled by Author.

Table B-7

FACTOR RANKINGS FOR RECREATION TRIP BY USER TYPES

Factors	Bike/Walk	Casual	Bike Buff	Utility
Weather	1	1	1	1
Temperature	2	3	5	6
Wind Velocity and Direction	4	7.5	8.5	13.5
Darkness/Light	5	9	6.5	10.5
Steepness of Grades	7	7.5	12	4
Traffic (speed of vehicles)	13	14.5	10	7
Traffic (number of vehicles)	6	4	2	5
Traffic (number of heavy vehicles)	8.5	14.5	11	13.5
Number of Pedestrians	16.5	17.5	18	18
Number of Stop Signs	16.5	16	14	16
Amount of Cross Traffic	13	12.5	15	17
Distance	10	11	13	8
Time Necessary to Complete Trip	16.5	10	16.5	3
Condition of Road Surface	8.5	5	6.5	2
Attractive Scenery Along Route	3	2	3	10.5
Accident Potential (safety)	11	6	4	12
Noise and Air Quality	13	12.5	8.5	15
Directness	16.5	17.5	16,5	9

Source: Compiled by Author.

Table B-8

FACTOR RANKINGS FOR WORK TRIP BY USER TYPES

Factors	Bike/Walk	Casual	Bike Buff	Utility
Weather	1	1	2.5	1
Temperature	2	9	11	10
Wind VElocity and Direction	9.5	10	16	13.5
Darkness/Light	4	11	9	12
Steepness of Grades	9.5	7	11	4
Traffic (speed of vehicles)	12	12	8	5.5
Traffic (number of vehicles)	7	3	6	3
Traffic (number of heavy vehicles)	17	13	11	11
Number of Pedestrians	17	17	17.5	17
Number of Stop Signs	14	14.5	13	17
Amount of Cross Traffic	13	14.5	17.5	13.5
Distance	6	5	4	7.5
Time Necessary to Complete Trip	5	2	1	5.5
Condition of Road Surface	9.5	8	7	9
Attractive Scenery Along Route	15	16	15.5	15
Accident Potential (safety)	9.5	6	5	7.5
Noise and Air Quality	17	18	15.5	17
Directness	3	4	2.5	2

Source: Compiled by Author.

Table B-9

FACTOR RANKINGS FOR SHOPPING TRIPS BY USER TYPES

Factors	Bike/Walk	Casual	Bike Buff	Utility
Weather	1	1	1	3
Temperature	4.5	9	10	15
Wind Velocity and Direction	3	11	13,5	10
Darkness/Light	2	10	9	13
Steepness of Grades	11.5	6.5	11	1
Traffic (speed of vehicles)	13	13.5	8	2
Traffic (number of vehicles)	4.5	3	4	4
Traffic (number of heavy vehicles)	17	13.5	12	9
Number of Pedestrians	17	16	17	17.5
Number of Stop Signs	11.5	12	17	17.5
Amount of Cross Traffic	10	17	13.5	13
Distance	8.5	2	7	6
Time Necessary to Complete Trip	8.5	8	6	11
Condition of Road Surface	14.5	4	4	7
Attractive Scenery Along Route	14.5	15	17	13
Accident Potential (safety)	6	6.5	2	5
Noise and Air Quality	17	18	15	16
Directness	7	5	4	8

Source: Compiled by Author.

Table B-10

FACTOR RANKINGS FOR SCHOOL TRIP BY USER TYPES

Factors	Bike/Walk	Casual	Bike Buffs	Utility
Weather	1	1	1	1
Temperature	8.5	4	7.5	11
Wind Velocity and Direction	16.5	11	12.5	10
Darkness/Light	11	17	7.5	13
Steepness of Grades	12	6	16.5	5.5
Traffic (speed of vehicles)	13.5	12.5	9	8
Traffic (number of vehicles)	6	5	6	4
Traffic (number of heavy vehicles)	16.5	12.5	12,5	15.5
Number of Pedestrians	16.5	10	14	17
Number of Stop Signs	10	14.5	11	14
Amount of Cross Traffic	13.5	14.5	16.5	12
Distance	2	9	10	7
Time Necessary to Complete Trip	6	2	2	3
Condition of Road Surface	4	8	5	5.5
Attractive Scenery Along Route	3	16	16.5	15.5
Accident Potential (safety)	6	7	3	9
Noise and Air Quality	16.5	18	16.5	18
Directness	8.5	3	4	2

Source: Compiled by Author.

Table B-11

FACTOR RANKINGS FOR HEALTH TRIPS BY USER TYPES

Factors	Bike/Walk	Casual	Bike Buff	Utility
Weather	2	1	2.5	1
Temperature	7.5	3.5	9	10.5
Wind Velocity and Direction	9	11.5	9	7
Darkness/Light	12	7	5	10.5
Steepness of Grades	5.5	3.5	7	3
Traffic (speed of vehicles)	10.5	14	13.5	12.5
Traffic (number of vehicles)	7.5	5	1	4
Traffic (number of heavy vehicles)	13.5	13	9	17
Number of Pedestrians	13.5	15	17.5	18
Number of Stop Signs	16	16	12	14
Amount of Cross Traffic	15	17	16	15
Distance	5.5	10	11	7.5
Time Necessary to Complete Trip	4	9	13.5	7.5
Condition of Road Surface	2	6	2.5	2
Attractive Scenery Along Route	2	2	6	5.5
Accident Potential (safety)	10.5	8	4	5.5
Noise and Air Quality	17.5	11.5	15	12.5
Directness	17.5	18	17.5	16

Source: Compiled by Author.

Table B-13

FACTOR RANKINGS FOR RECREATION TRIP BY AGE

Factors	Under 20	20 to 29	30 and up
Weather	1	1	3.5
Temperature	2	3	7.5
Wind Velocity and Direction	7	8.5	11
Darkness/Light	6	8.5	12.5
Steephess of Grade	5	6	7.5
Traffic (speed of vehicles)	17	10	12.5
Traffice (number of vehicles)	4	4	5
Traffic (number of heavy vehicles)	17	13	9
Number of Pedestrians	17	18	16.5
Number of Stop Signs	12	17	16.5
Amount of Cross Traffic	14	15	16.5
Distance	11	14	6
Time Necessary to Complete Trip	10	11	10
Condition of Road Surface	8	5	1
Attractive Scenery Along Route	3	2	2
Accident Potential (safety)	9	7	3.5
Noise and Air Quality	15	12	14
Directness	13	6	16.5

Source: Compiled by Author.

Table B-14

FACTOR RANKINGS FOR WORK TRIP BY AGE

Factors	Under 20	20 to 29	30 and up
Weather	1	1	2
Temperature	6	10.5	9.5
Wind Velocity and Direction	11	10.5	14.5
Darkness/Light	2.5	16.5	11
Steepness of Grades	8	6	9.5
Traffic (speed of vehicles)	15	8	6.5
Traffic (number of vehicles)	4	3	5
Traffic (number of heavy vehicles)	13.5	12	12.5
Number of Pedestrians	18	16.5	17
Number of Stop Signs	17	14	12.5
Amount of Cross Traffic	13.5	13	14.5
Distance	7	5	6.5
Time Necessary to Complete Trip	2.5	2	8
Condition of Road Surface	10	9	4
Attractive Scenery Along Route	12	15	17
Accident Potential (safety)	9	7	2
Noise and Air Quality	16	18	17
Directness	5	4	2

Source: Completed by Author.

Table B-15

FACTOR RANKINGS FOR SHOPPING TRIP BY AGE

Factors	Under 20	20 to 29	30 and up
Weather	1	1	2
Temperature	7	11	7.5
Wind Velocity and Direction	11	10	14
Darkness/Light	2.5	13.5	9.5
Steepness of Grade	2.5	8	7.5
Traffic (speed of vehicles)	11	7	9.5
Traffic (number of vehicles)	5	2	4
Traffic (number of heavy vehicles)	15	13.5	12
Number of Pedestrians	16	18	16.5
Number of Stop Signs	14	17	11
Amount of Cross Traffic	11	12	16.5
Distance	7	3.9	4
Time Necessary to Complete Trip	4	9	13
Condition of Road Surface	13	5.5	4
Attractive Scenery Along Routes	18	15	16.5
Accident Potential (safety)	9	3.5	1
Noise and Air Quality	17	16	16.5
Directness	7	5.5	6

Source: Compiled by Author.

Table B-16

FACTOR RANKINGS FOR SCHOOL TRIP BY AGE

Factors	Under 20	20 to 29	30 and up
Weather	1	1	3
Temperature	4	6.5	5.5
Wind Velocity and Diredtion	14	11	8
Darkness/Light	8.5	16	11
Steepness of Grades	6.5	10	5.5
Traffic (speed of vehicles)	16.5	9	12.5
Traffic (number of vehicles)	6.5	4	7
Traffic (number of heavy vehicles)	16.5	12	16
Number of Pedestrians	12.5	14.5	16
Number of Stop Signs	11	14.5	9.5
Amount of Cross Traffic	15	13	16
Distance	5	8	9.5
Time Necessary to Complete Trip	2	2	12.5
Condition of Road Surface	10	5	4
Attractive Scenery Along Route	12.5	17	16
Accident Potential (safety)	8.5	6.5	1
Noise and Air Quality	18	18	16
Directness	3	3	2

Source: Compiled by Author.

Table B-17

FACTOR RANKINGS FOR HEALTH TRIP BY AGE

Factors	Under 20	20 to 29	30 and up
Weather	1	1	5
Temperature	4	6	12
Wind Velocity and Direction	9	10	16
Darkness/Light	2	8	11
Steepness of Grade	7.5	2	6
Traffic (speed of vehicles)	18	11	7.5
Traffic (number of vehicles)	11	4	1.5
Traffic (number of heavy vehicles)	14.5	14	7.5
Number of Pedestrians	14.5	17	16
Number of Stop Signs	12	15	16
Amount of Cross Traffic	13	16	16
Distance	7.5	12	9
Time Necessary to Complete Trips	6	9	13
Condition of Road Surface	3	5	1.5
Attractive Scenery Along Route	.5	3	3
Accident Potential (safety)	10	7	4
Noise and Air Quality	17	13	10
Directness	16	18	16

Source: Compiled by Author.

Table B-18

FACTOR RANKINGS FOR PERSONAL BUSINESS TRIP BY AGE

Factors	Under 20	20 to 29	30 and up
Weather	1	1	2.5
Temperature	7	3	8
Wind Velocity and Direction	10.5	13.5	14.5
Darkness/Light	3	6.5	12.5
Steepness of Grade	10.5	9	6
Traffic (speed of vehicles)	17.5	11	10.5
Traffic (number of vehicles)	9	2	2.5
Traffic (number of heavy vehicles)	13.5	15	14.5
Number of Pedestrians	17.5	13.5	16
Number of Stop Signs	16	18	12.5
Amount of Cross Traffic	12	16	16
Distance	5	6.5	6
Time Necessary to Complete Trip	2	4	9
Condition of Road Surface	4	5	4
Attractive Scenery Along Route	15	9	10.5
Accident Potential (safety)	8	9	1
Noise and Air Quality	13.5	17	16
Directness	6	12	6

Source: Compiled by Author.

Table B-19

FACTOR RANKINGS FOR RECREATION TRIP BY SEX

Factors	Male	Female
Weather	1	1
Temperature	3	4
Wind Velocity and Direction	8	8
Darkness/Light	7	9
Steepness of Grade	6	7
Traffic (speed of vehicles)	11	12
Traffic (number of vehicles)	4	6
Traffic (number of heavy vehicles)	14	14
Number of Pedestrians	18	17.5
Number of Stop Signs	17	15
Amount of Cross Traffic	15.5	16
Distance	13	10.5
Time Necessary to Complete Trip	10	10.5
Condition of Road Surface	5	3
Attractive Scenery Along Route	2	2
Accident Potential (safety)	9	5
Noise and Air Quality	12	13
Directness	15.5	17.5

Source: Compiled by Author.

Table B-20

FACTOR RANKINGS FOR WORK TRIP BY SEX

Factors	Male	Female
Weather	1	2.5
Temperature	9	10.5
Wind Velocity and Direction	12	13.5
Darkness/Light	11	13.5
Steepness of Grade	8	6
Traffic (speed of vehicles)	10	9
Traffic (number of vehicles)	3	2.5
Traffic (number of heavy vehicles)	13	13.5
Number of Pedestrians	17	17.5
Number of Stop Signs	15	13.5
Amount of Cross Traffic	14	10.5
Distance	5	8
Time Necessary to Complete Trip	2	5
Condition of Road Surface	7	7
Attractive Scenery Along Route	16	16
Accident Potential (safety)	6	4
Noise and Air Quality	18	17.5
Directness	4	1

Source: Compiled by Author.

Table B-21

FACTOR RANKINGS FOR SHOPPING TRIP BY SEX

Factors	Male	Female
Weather	1	1
Temperature	10	16.5
Wind Velocity and Direction	12	10
Darkness/Light	11	12.5
Steepness of Grade	6.5	4
Traffic (speed of vehicles)	8	8
Traffic (number of vehicles)	4	2
Traffic (number of heavy vehicles)	14	12.5
Number of Pedestrians	16.5	18
Number of Stop Signs	16.5	12,5
Amount of Cross Traffic	13	12.5
Distance	3	7
Time Necessary to Complete Trip	9	9
Condition of Road Surface	5	5.5
Attractive Scenery Along Route	15	15
Accident Potential (safety)	2	5.5
Noise and Air Quality	18	16.5
Directness	6.5	3

Source: Compiled by Author.

Table B-22

FACTOR RANKINGS SCHOOL TRIP BY SEX

Factors	Male	Female
Weather	1	1
Temperatyre	5	8
Wind Velocity and Direction	11	12
Darkness/Light	13	16
Steepness of Grade	9	5
Traffic (speed of vehicles)	10	9
Traffic (number of vehicles)	4	4
Traffic (number of heavy vehicles)	16	13
Number of Pedestrians	17	11
Number of Stop Signs	12	17
Amount of Cross Traffic	14	15
Distance	8	10
Time Necessary to Complete Trip	2	3
Condition of Road Surface	6	7
Attractive Scenery Along Route	15	14
Accident Potential	7	6
Noise and Air Quality	18	18
Directness	3	2

Source: Compiled by Author.

Table B-23

FACTOR RANKINGS FOR HEALTH TRIPS BY SEX

Factors	Male	Female
Weather	1	1
Temperature	6	8
Wind Velocity and Direction	9	13
Darkness/Light	7	16.5
Steepness of Grade	4	3
Traffic (speed of vehicles)	14	10
Traffic (number of vehicles)	3	5
Traffic (number of heavy vehicles)	12	11
Number of Pedestrians	16	16.5
Number of Stop Signs	15	13
Amount of Cross Traffic	17	15
Distance	11	7
Time Necessary to Complete Trip	10	9
Condition of Road Surface	2	4
Attractive Scenery Along Route	5	2
Accident Potential (safety)	8	6
Noise and Air Quality	13	13
Directness	18	18

Source: Compiled by Author.

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Table B-24

FACTOR RANKINGS FOR PERSONAL BUSINESS TRIPS BY SEX

Factors	Male	Female
Weather	1	1
Temperature	2	10
Wind Velocity and Direction	13	17
Darkness/Light	6	8
Steepness of Grade	8.5	12.5
Traffic (speed of vehicles)	10	12.5
Traffic (number of vehicles)	3	2
Traffic (number of heavy vehicles)	14.5	11
Number of Pedestrians	16.5	18
Number of Stop Signs	18	15.5
Amount of Cross Traffic	14.5	14
Distance	8.5	4.5
Time Necessary to Complete Trip	4	6
Condition of Road Surface	5	4.5
Attractive Scenery Along Route	12	9
Accident Potential (safety)	7	7
Noise and Air Quality	16.5	15.5
Directness	11	3

Source: Compiled by Author.

Table B-25

FACTOR RANKINGS FOR RECREATION TRIP BY EDUCATION

Factors	Some College	College	Some Grad/Grad
Weather	1	1	1
Temperature	3	8.5	6.5
Wind Velocity and Direction	8	8.5	8
Darkness/Light	7	11	13.5
Steepness of Grade	5	12	6.5
Traffic (speed of vehicles)	11	10	11
Traffic (number of vehicles)	4	4	5
Traffic (number of heavy vehicles)	12.5	15	11
Number of Pedestrians	18	17	18
Number of Stop Signs	16.5	17	15.5
Amount	16.5	13	15.5
Distance	14	6	11
Time Necessary to Complete Trip	10	5	13.5
Condition of Road Surface	6	3	3.5
Attractive Scenery Along Route	2	2	2
Accident Potential (safety)	9	7	3.5
Noise and Air Quality	12.5	14	9
Directness	15	17	17

Source: Compiled by Author.

Table B-26

FACTOR RANKINGS FOR WORK TRIP BY EDUCATION

Factors	Some College	College	Some Grad/Grad
Weather	1	1.5	3
Temperature	9	9	11,5
Wind Velocity and Direction	13.5	12	10
Darkness/Light	10	16.5	11.5
Steepness of Grade	7	5.5	6.5
Traffic (speed of vehicles)	11	8	8.5
Traffic (number of vehicles)	3	1.5	8.5
Traffic (number of heavy vehicles)	13.5	11	15.5
Number of Pedestrians	17	16.5	18
Number of Stop Signs	15	13	13
Amount of Cross Traffic	12	16.5	14
Distance	6	7	5
Time Necessary to Complete Trip	2	3,5	2
Condition of Road Surface	5	10	6.5
Attractive Scenery Along Route	16	14	15.5
Accident Potential (safety)	8	5.5	4
Noise and Air Quality	18	16.5	17
Directness	4	3.5	1

Source: Compiled by Author

Table B-27

FACTOR RANKINGS FOR SHOPPING TRIP BY EDUCATION

Factors	Some College	College	Some Grad/Grad
Weather	1	1	2.5
Temperature	10	11.5	9.5
Wind Velocity and Direction	13	7	13
Darkness/Light	7.5	16.5	17
Steepness of Grade	7.5	3	7.5
Traffic (speed of vehicles)	10	5.5	7.5
Traffic (number of vehicles)	2	2	4
Traffic (number of heavy vehicles)	14	13	13
Number of Pedestrians	16	16.5	18
Number of Stop Signs	15	16.5	15.5
Amount of Cross Traffic	12	16.5	15.5
Distance	3	9.5	2.5
Time Necessary to Complete Trip	10	4	9.5
Condition of Road Surface	6	8	5
Attractive Scenery Along Route	17.5	11.5	11
Accident Potential (safety)	4.5	9.5	1
Noise and Air Quality	17.5	14	13
Directness	4.5	5.5	6

Source: Compiled by Author.

Table B-28

FACTOR RANKINGS FOR SCHOOL TRIP BY EDUCATION

Factors	Some College	College	Some Grad/Grad
Weather	1	1	1
Temperature	5	9.5	7
Wind Velocity and Direction	10.5	11	13
Darkness/Light	12.5	15	13
Steepness of Grade	9	4	8
Traffic (speed of vehicles)	10.5	12	9
Traffic (number of vehicles)	4	6	5
Traffic (number of heavy vehicles)	17	13	16
Number of Pedestrians	14	17	17,5
Number of Stop Signs	12.5	17	13
Amount of Cross Traffic	15	17	13
Distance	6	9.5	10
Time Necessary to Complete Trip	2	2	4
Condition of Road Surface	7.5	5	6
Attractive Scenery Along Route	16	8	13
Accident Potential (safety)	7.5	7	3
Noise and Air Quality	18	14	17,5
Directness	3	3	2

Source: Compiled by Author.

Table B-29

FACTOR RANKINGS FOR HEALTH TRIP BY EDUCATION

Factors	Some College	College	Some Grad/Grad
Weather	1	1	2
Temperature	5	9	8.5
Wind Velocity and Direction	11	7	11
Darkness/Light	7	10	13
Steepness of Grad	4	2.5	3.5
Traffic (speed of vehicles)	12	15	7
Traffic (number of vehicles)	3	7	5
Traffic (number of heavy vehicles)	13	12	10
Number of Pedestrians	16	15	18
Number of Stop Signs	14	15	15
Amount of Cross Traffic	17	15	16
Distance	10	11	8.5
Time Necessary to Complete Trip	8	15	14
Condition of Road Surface	2	2.5	6
Attractive Scenery Along Route	6	4	1
Accident Potential (safety)	9	6	3,5
Noise and Air Quality	15	7	12
Directness	18	15	17

Source: Compiled by Author.

Table B-30

FACTOR RANKINGS FOR PERSONAL BUSINESS TRIP BY EDUCATION

Factors	Some College	College	Some Grad/Grad
Weather	1	1	1
Temperature	5	5	3
Wind Velocity and Direction	11.5	13,5	17
Darkness/Light	6	7.5	12
Steepness of Grades	9.5	3	11
Traffic (speed of vehicles)	13	9.5	10
Traffic (number of vehicles)	3	2	5
Traffic (number of heavy vehicles)	15	13.5	14
Number of Pedestrians	17	17	18
Number of Stop Signs	18	15	16
Number of Cross Traffic	14	17	14
Distance	7	5	9
Time Necessary to Complete Trip	2	7.5	5
Condition of Road Surface	4	9.5	5
Attractive Scenery Along Route	11.5	12	8
Accident Potential (safety)	9.5	5	2
Noise and Air Quality	16	17	14
Directness	8	11	7

Source: Compiled by Author.

Table B-31

FACTOR RANKINGS FOR RECREATION BY INCOME

Factors	0-7000	7-12000	12-15000	15-23000	25
Weather	1	1	1	1	1
Temperature	6	3	4,5	4	3
Wind Velocity and Direction	13	6	6	9	6.5
Darkness/Light	4	9	4.5	10.5	8
Steepness of Grade	7	6	8	5	6,5
Traffic (speed of vehicles)	8	12	9.5	13	11
Traffic (number of vehicles)	5	6	3	7	4
Traffic (number of heavy vehicles)	9	12	13.5	14	10
Number of Pedestrians	18	17.5	17.5	17	18
Number of Stop Signs	17	14	17.5	15.5	16
Number of Cross Traffic	14.5	15	13.5	18	16
Distance	14.5	16	15	8	12.5
Time Necessary to Complete Trip	11	10	9.5	10.5	12.5
Condition of Road Surface	11	4	7	3	5
Attractive Scenery Along Route	2	2	2	2	2
Accident Potential (safety)	3	8	11	6	9
Noise and Air Quality	11	12	12	12	14
Directness	16	17.5	16	15.5	16

Source: Compiled by Author.

Table B-32

FACTOR RANKINGS FOR WORK TRIP BY INCOME

Factors	0-7000	7-12000	12-15000	15-25000	25
Weather	1	5.5	1	1	1
Temperature	8	11	14	9	7.5
Wind Velocity and Direction	11	15.5	11	11	15
Darkness/Light	14.5	12	10	8	9.5
Steepness of Grade	9.5	3	9	5	7.5
Traffic (speed of vehicles)	7	8	7.5	12	9.5
Traffic (number of vehicles)	4.5	1.5	3	10	2
Traffic (number of heavy vehicles)	14.5	7	12.5	15.5	12
Number of Pedestrians	17.5	15.5	16	17.5	17
Number of Stop Signs	12.5	15.5	15	14	16
Amount of Cross Traffic	12.5	15.5	12.5	17.5	12
Distance	6	5.5	5	3	12
Time Necessary to Complete Trip	4.5	1.5	2	4	3
Condition of Road Surface	9.5	9	6	7	5
Attractive Scenery Along Route	16	15.5	17.5	15.5	14
Accident Potential (safety)	2	10	7.5	6	6
Noise and Air Quality	17.5	15.5	17.5	13	18
Directness	3	4	4	2	4

Source: Compiled by Author.

Table B-33

FACTOR RANKINGS FOR SHOPPING TRIP BY INCOME

Factors	0-7000	7-12000	12-15000	15-25000	25
Weather	1	4	2	1	1
Temperature	13	13	11.5	11	7.5
Wind Velocity and Direction	13	6	14	9	15
Darkness/Light	6.5	13	5.5	12	11
Steepness of Grades	15.5	10	5.5	3	3.5
Traffic (speed of vehicles	2	2	11.5	10	9
Traffic (number of vehicles)	6.5	1	1	8	5
Traffice (number of heavy vehicles)	11	10	13	14	12
Number of Pedestrians	18	17	16.5	17	16.5
Number of Stop Signs	17	13	15	17	13.5
Amount of Traffic	13	15	9	17	10
Distance	3	10	3	6	3.5
Time Necessary to Complete Trip	8	7.5	7.5	7	13.5
Condition of Road Surface	10	5	4	5	6
Attractive Scenery Along Route	9	17	16.5	15	16.5
Accident Potential (safety)	4	7.5	7.5	2	2
Noise and Air Quality	15.5	17	18	13	8
Directness	5	3	10	4	7.5

Source: Compiled by Author.

Table B-34

FACTOR RANKINGS FOR SCHOOL TRIP INCOME

Factors	0-7000	7-12000	12-15000	15-25000	25
Weather	1	1	1	1	1
Temperature	9	7	5	8.5	4
Wind Velocity and Direction	13	12	13	11	8
Darkness/Light	10.5	18	12	12	14
Steepness of Grade	10.5	5	9.5	8.5	7
Traffic (speed of vehicles)	4	8	16.5	13.5	13
Traffic (number of vehicles)	3	6	4	7	6
Traffic (number of heavy vehicles)	14	9	14.5	16.5	16.5
Number of Pedestrians	17.5	10	9.5	16.5	15
Number of Stop Signs	16	15	14.5	10	12
Amount of Cross Traffic	12	13	11	15	16.5
Distance	7.5	11	7	6	9
Time Necessary to Complete Trip	5	2	2	2	3
Condition of Road Surface	7.5	4	7	5	10
Attractive Scenery Along Route	15	15	16.5	13.5	11
Accident Potential (safety)	6	15	7	4	5
Noise and Air Quality	17.5	17	18	18	18
Directness	2	3	3	3	2

Source: Compiled by Author

Table B-35

FACTOR RANKINGS FOR HEALTH TRIP BY INCOME

Factors	0-7000	7-12000	12-15000	15-25000	25
Weather	1	1	1	1	1
Temperature	10	3	11	5	6
Wind Velocity and Direction	12	7.5	13	9.5	10.5
Darkness/Light	8	5.5	8	8	7.5
Steepness of Grade	8	4	3.5	4	3
Traffic (speed of vehicles)	15	12	8	17	14
Traffic (number of vehicles)	3	7.5	3.5	7	4
Traffic (number of heavy vehicles)	13	10	8	13	14
Number of Pedestrians	16	17.5	14	14	17
Number of Stop Signs	14	13.5	15.5	15	16
Amount of Cross Traffic	17.5	17.5	15,5	17	12
Distance	11	11	6	9.5	9
Time Necessary to Complete Trip	6	16	2	11	14
Condition of Road Surface	5	2	5	2.5	5
Attractive Scenery Along Route	4	5.5	16	2.5	2
Accident Potential (safety)	2	9	12	6	7.5
Noise and Air Quality	8	15	17	12	10.5
Directness	17.5	13.5	18	17	18

Source: Compiled by Author.

Table B-36

FACTOR RANKINGS FOR PERSONAL BUSINESS BY INCOME

Factors	0-7000	7-12000	12-15000	15-25000	25
Weather	1	1	3	1	1
Temperature	5	3	5.5	4.5	5,5
Wind Velocity and Direction	15.5	9	10.5	12	14.5
Darkness/LIght	7,5	4.5	10.5	9	2.5
Steepness of Grade	13.5	8	8	8	11.5
Traffic (speed of vehicles)	2	10.5	13.5	13	17
Traffic (number of vehicles)	5	2	2	6.5	8
Traffic (number of vehicles)	9.5	12	16.5	17	13
Traffic (number of heavy vehicles)	9.5	12	16,5	17	13
Number of Pedestrians	17.5	16.5	13.5	17	17
Number of Stop Signs	15.5	16.5	15	15	17
Amount of Cross Traffic	17.5	16.5	10.5	17	11.5
Distance	9.5	6.5	7	4,5	5.5
Time Necessary to Complete Trip	12	10.5	1	6.5	2.5
Condition of Road Surface	5	4.5	4	2	9.5
Attractive Scenery Along Route	7.5	6.5	18	10	9.5
Accident Potential (safety)	3	14	10.5	3	7
Noise and Air Quality	13.5	16.5	16,5	14	14.5
Directness	11	13	5.5	11	4

Source: Compiled by Author.

ABSTRACT

In recent years the bicycle has become a more popular alternative mode of travel for the urban commuter in the United States. In response to modal conflicts and increasing numbers of accidents involving bicyclists, transportation planners have turned to the development of bikeways to integrate bicycles into the transportation system. Presently planners stress the physical nature (engineering) of bikeways, while not studying the future users (bicyclists) in enough detail to consider their perception of what factors make a route or facility more appealing to use. This study looked at bicyclists' route selection behavior in detail. The study assumed that the routes taken by bicyclists in Manhattan, Kansas were the result of a route selection process in which many factors were weighed in determining the route to be taken.

The purpose of this study was to answer the following five questions: (1) What factors are important in the selection of a route by a bicyclist? (2) How do these vary with trip purpose? (3) How do the factors vary with the different types of users? and (5) How do the actual bike route choices vary from minimum distance paths?

The study surveyed 122 respondents to answer the questions listed above. The key segment of the survey involved the scaling and ranking of 18 factors of route selection. The factors represented weather, traffic, environment, road, and personal conditions encountered along a route. Spearman's ranked-order correlation coefficient was used to test the degree of similarity between sets of ranked factors for groups of respondents showing different user socio-economic characteristics. The significance of those correlations from zero were also tested as was the significance between different pairs of correlations. A t test was used in analyzing the actual versus minimum distance data.

For all trips, bicyclists were concerned with, in order of importance,

weather, condition of road surface, safety, traffic conditions, and attractive scenery in the route taken. The least important factors of route selection for all trips in order of least importance were the number of pedestrians and stop signs, amount of cross traffic, noise and air quality. The route factor selection behavior was investigated for the socio-economic categories which included age groups, sex, education groups, and income groups. For all trips, the user types (bike/walk only, casual, bike buff, and utility) had similarity in factor selection. In the socio-economic categories, only the group aged thirty and older had significant variations in its factor selection when compared to the other age groups. All of the other socio-economic categories had similar route factor selections.

Comparisons of factor selection for different trip purposes revealed that recreation and health trip factors were similar as they stressed weather, road, and environmental conditons. Work, shop, and school trips however, stressed weather, personal (time related) factors and safety. Personal business trip factors were similar to all of the other trips. For specific trip purposes, different socio-economic groups had similar route factor selection. It was found that bicyclists take minimum time paths.

The study attempted to make a contribution of the study of individual movement behavior by looking at the preference route characteristics of bicyclists. This study will hopefully stimulate interest in others in this mode.